SmartPilot X5

Tiller & GP Tiller Installation & Setup Guide

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Preface

Safety notices

WARNING: Product installation & operation

This equipment must be installed, commissioned and operated in accordance with the Raymarine instructions provided. Failure to do so could result in personal injury, damage to your boat and/or poor product performance.

WARNING: Switch off power supply

Make sure you have switched off the power supply before you start installing this product.

WARNING: Navigational safety

Although we have designed this product to be accurate and reliable, many factors can affect its performance. Therefore, it should serve only as an aid to navigation and should never replace commonsense and navigational judgement. Always maintain a permanent watch so you can respond to situations as they develop.

EMC Conformance

All Raymarine equipment and accessories are designed to the best industry standards for use in the recreational marine environment. Their design and manufacture conforms to the appropriate Electromagnetic Compatibility (EMC) standards, but correct installation is required to ensure that performance is not compromised.

Limitations on pressure washing

CAUTION: Do not pressure wash Raymarine products

Raymarine products must NOT be subjected to water pressures in excess of CFR46 / IPX6 standards (for example, as generated by commercial high pressure washing equipment). Products subjected to water at these high pressures may experience water intrusion and subsequent failure.

Raymarine products are waterproofed to CFR46 / IPX6 standards, which means that when installed and operated in accordance with the appropriate product documentation, they can be used in most weather and sea conditions. However, any exposure to high-pressure water that exceeds the CFR46 / IPX6 standards, on or around Raymarine products will invalidate the warranty for those products.

Product documents

This document is part of a series of books associated with the SPX-5 Tiller system. Documents can be downloaded from www.raymarine.com/handbooks.

Title	Part number
SmartPilot X-5 Tiller and GP Tiller Operating Guide	81303
SmartPilot X-5 Tiller and GP Tiller Installation and Setup Guide	87075
ST6002 Controller installation sheet	87058
ST6002 SmartPilot Controller - Tiller Quick Reference Guide	86131
Fluxgate compass installation sheet	87011
Warranty Booklet	80017

To the best of our knowledge, the information in the product documents was correct when they went to press. However, Raymarine cannot accept liability for any inaccuracies or omissions in product documents.

In addition, our policy of continuous product improvement may change specifications without notice. Therefore, Raymarine cannot accept liability for any differences between the product and the accompanying documents.

Warranty

To register your new Raymarine product, please take a few minutes to fill out the warranty card. It is important that you complete the owner information and return the card to us to receive full warranty benefits. You can also register online at www.raymarine.com by following the **Login or create an account** link.

Product disposal

Waste Electrical and Electronic (WEEE) Directive

The European WEEE Directive requires that waste electrical and electronic equipment is recycled.

Products carrying the crossed out wheeled bin symbol (illustrated above) must not be disposed of in general waste or landfill, but in accordance with local regulations for such products.

Although the WEEE Directive does not apply to all Raymarine products, we support its policy and ask you to be aware of the correct method for disposing of such products.

Please contact your local dealer, national distributor or Raymarine Technical Services for information on product disposal.

Chapter 1: Installation and system overviews

This chapter gives an overview of installation procedures and network configurations for an SPX-5 Tiller system.

1.1 Installation overview

There are two stages to installing an SPX-5 Tiller system, namely planning the installation, then installing and mounting the components.

It is important to carry out the planning stage, to ensure that all components used in the system, including cables and accessories, are correctly specified and located.

The following is a summary of the tasks in each stage.

Planning

1. Understand your system.
2. Check equipment supplied.
3. Establish suitable locations for the autopilot equipment.
4. Plan cabling and connections.
5. Produce a schematic diagram.

Installing

1. Mount SPX-5 Course Computer.
2. Install Tiller Drive unit.
3. Install the autopilot controller.
4. Install the compass.
5. Connect power cables and system ground.
6. Connect additional equipment / cables to the Course Computer.
7. Final fix: secure all equipment in place; secure all cables.

1.2 Safe and successful installation

To achieve a safe and reliable installation of your SPX-5 Tiller system, installation must be carried out by a competent professional who should adhere to the instructions in this guide.

Certified installation

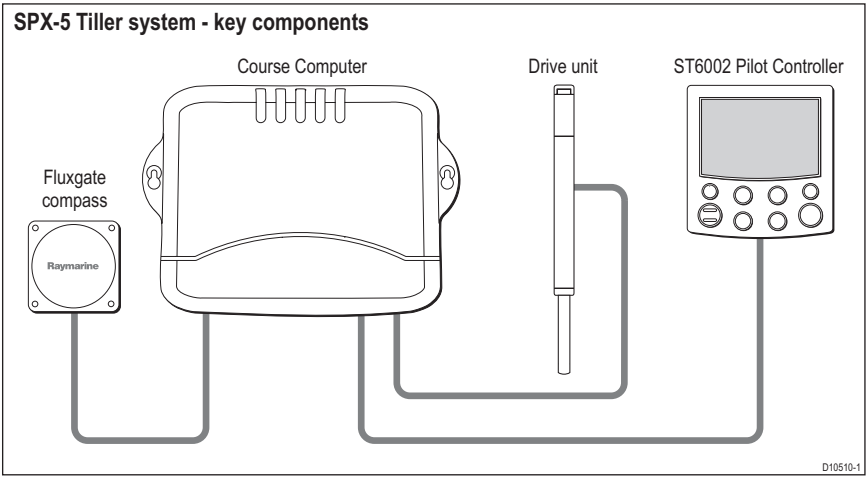
Raymarine recommends certified installation by a Raymarine approved installer. A certified installation qualifies for enhanced warranty benefits. Contact your Raymarine dealer for further details and refer to the separate warranty card packed with your product.

Getting assistance

If you need further assistance with an installation, contact your dealer or visit the Raymarine web site **www.raymarine.com**.

1.3 System overviews

The SPX-5 Tiller system consists of a number of components connected together using a Raymarine SeaTalk bus.



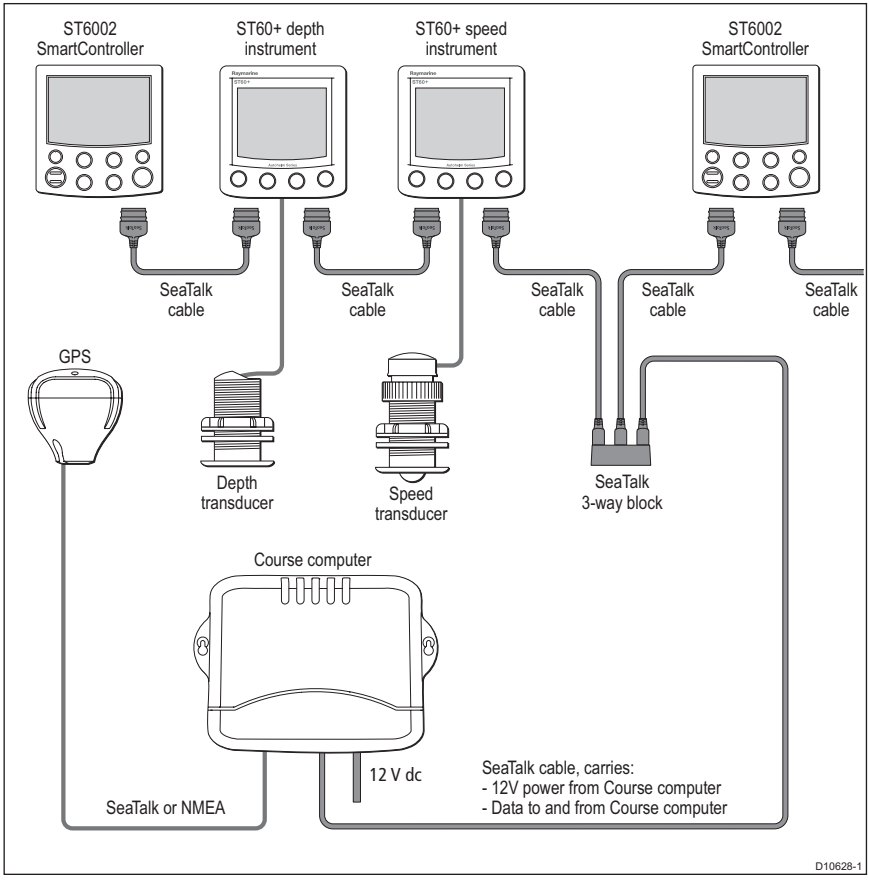
Marine electronics systems

The autopilot may form part of your wider ships electronics system. It may be connected to equipment using a number of marine industry standard protocols, including:

- SeaTalk.
- SeaTalk^{ng}
- NMEA 0183

Example SeaTalk system

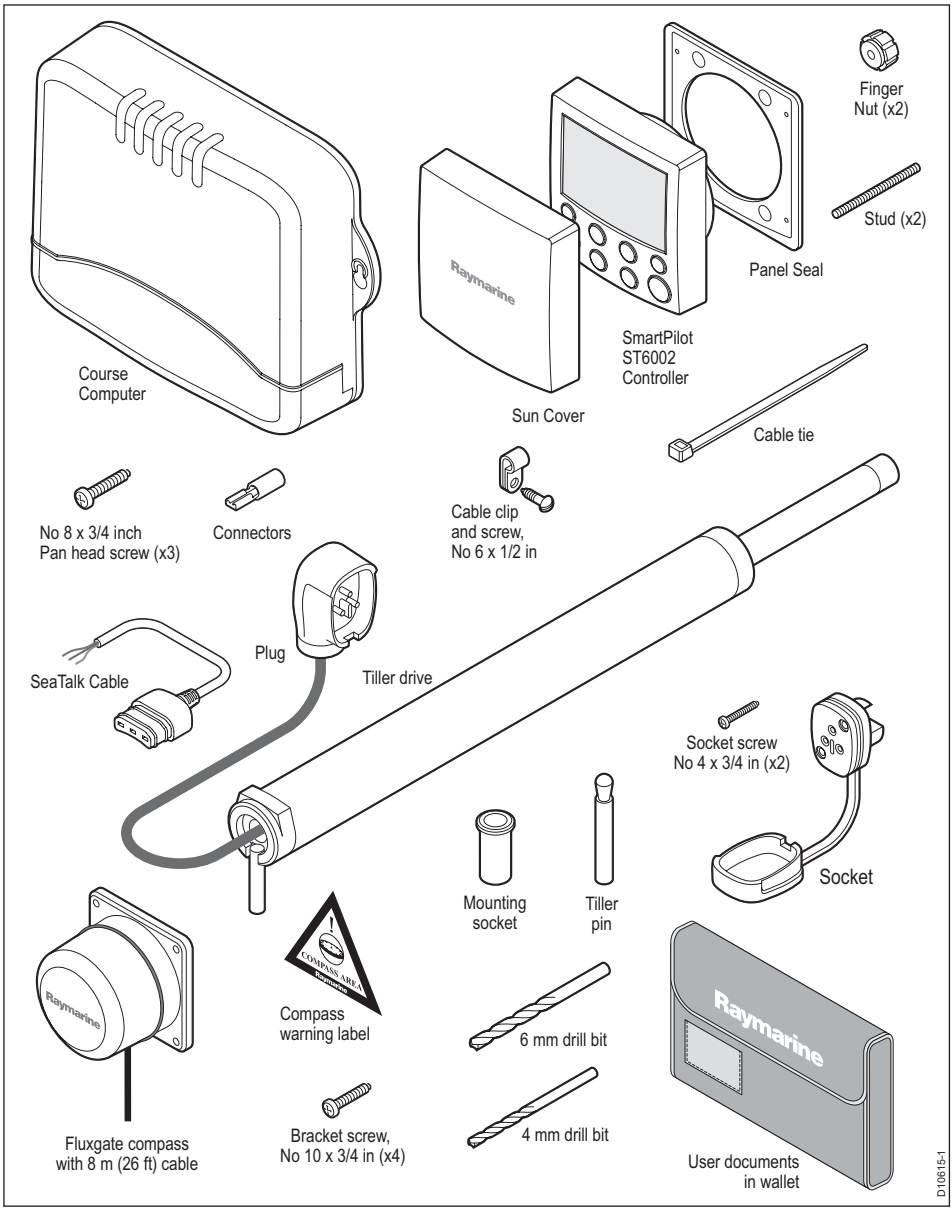
SeaTalk allows connection of compatible instruments and equipment though a dedicated data bus. This allows information sharing around the ships electronics system.



1.4 Equipment & Tools

Before you begin ensure you have all the necessary components and tools to install your system.

Parts supplied



Tools and equipment NOT supplied

You will need to supply the following equipment and tools:

Tools:

- Drill
- 2.5 mm ($^{3}/_{32}$"), 6 mm(1/4"), 12.5 mm (1/2"), 18 mm ($^{23}/_{32}$") drill bits
- Two-part epoxy (Araldite) adhesive
- Cross-head/pozi-drive screwdriver
- Slotted-head screwdriver

Cables / equipment

- Power cable and fuse/breaker. See *page 19*.
- Additional data cables (e.g. for connection of GPS or chartplotter)
- Grounding braid. See *page 25*.

Accessories

The following accessories may be used to adapt the tiller drive mounting to suit different installation requirements. See *Adapting the installation* on *page 16*.

Part Number	Description
D001	Tiller Pin (package of 5)
D002	Mounting Socket (package of 5)
D003	Pushrod Extension 25 mm (1")
D004	Pushrod Extension 51 mm (2")
D005	Pushrod Extension 76 mm (3")
D006	Pushrod Extension 102 mm (4")
D007	Pushrod Extension 127 mm (5")
D009	Tiller Bracket 25 mm (1")
D010	Tiller Bracket 51 mm (2")
D011	Tiller Bracket 76 mm (3")
D014	Small threaded tiller pin 25 mm (1")
D014	Small Thread Tiller Pin (package of 5)
D020	Extra length tiller pin 71 mm (2.8")
D021	Extra length threaded tiller pin 71 mm (2.8")
D026	Pedestal Socket 38 mm (1.5")
D027	Pedestal Socket 51 mm (2")
D028	Pedestal Socket 64 mm (2.5")

Part Number	Description
D029	Pedestal Socket 76 mm (3")
D030	Pedestal Socket 89 mm (3.5")
D031	Cantilever Socket
D159	Tiller Bracket 102 mm (4")
D160	Tiller Bracket 127 mm (5")

1.5 Create a schematic diagram

As part of the preparation for installing your SPX-5 Tiller system, we recommend that you create a schematic diagram representing the system you want to install. This will help ensure that you install a safe optimum system, and so is particularly important if you intend connecting your autopilot to other electronic equipment.

The schematic diagram should include:

- Location of all components. See *page v* and *page 7* for EMC guidelines that may affect the location of specific components.
- Connectors, cable types, routes and lengths.

When you have completed the schematic diagram, you are ready to begin installing the SPX-5 Tiller system.

Chapter 2: Installing the system

Before proceeding with the installation you should have the following to hand:

- All necessary equipment and tools to install your SPX-5 Tiller system..
- The correct type and length of power cable.
- Schematic diagram detailing autopilot system location and connections.

You should also check that existing marine electronics, such as the GPS are installed and working.

2.1 Installation precautions

WARNING: Install at dockside

For safety reasons your boat must be at dockside before commencing installation.

CAUTION: Switch off power supply

Switch off the power supply before you start installing this product.

EMC installation guidelines

Raymarine equipment and accessories conform to the appropriate Electromagnetic Compatibility (EMC) regulations. This minimizes electromagnetic interference between equipment, which could otherwise affect the performance of your system.

Correct installation is required to ensure that EMC performance is not compromised.

For optimum EMC performance, we recommend that:

- Raymarine equipment and the cables connected to it are:
  i. At least 3 ft (1 m) from any equipment transmitting or cables carrying radio signals e.g. VHF radios, cables and antennas. In the case of SSB radios, the distance should be increased to 7 ft (2 m).
  ii. More than 7 ft (2 m) from the path of a radar beam. A radar beam can normally be assumed to spread 20 degrees above and below the radiating element.
- The product is supplied from a separate battery from that used for engine start. This is important to prevent erratic behavior and data loss which can occur if the engine start does not have a separate battery.
- Raymarine specified cables are used.
- Cables are not cut or extended unless doing so is detailed in the installation manual.

Remember

Where constraints on the installation prevent any of the above recommendations:

- Always allow the maximum separation possible between different items of electrical equipment. This will provide the best conditions for EMC performance for the installation.

Suppression ferrites

Raymarine cables may be fitted with suppression ferrites. These are important for correct EMC performance. Any ferrite removed to facilitate installation must be replaced in the original position immediately after the installation is complete.

- Use only ferrites of the correct type, supplied by Raymarine authorized dealers.

Connections to other equipment

If Raymarine equipment is to be connected to other equipment using a cable not supplied by Raymarine, a Raymarine suppression ferrite MUST always be attached to the cable near the Raymarine unit.

Compass

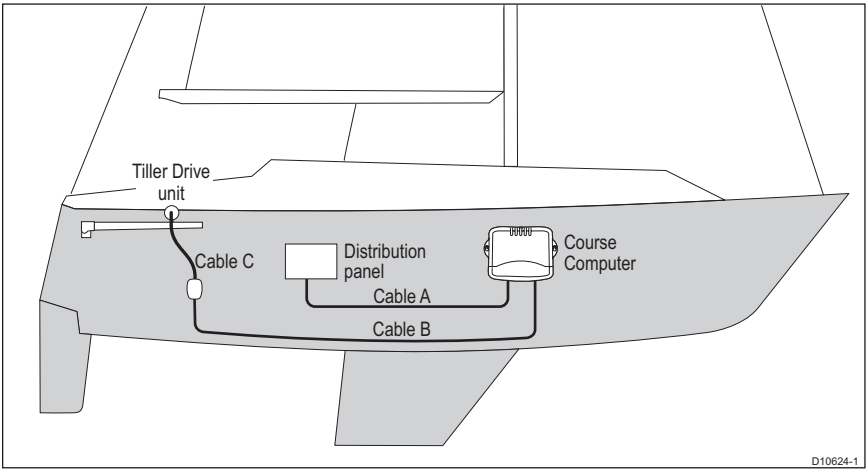
The compass is sensitive to magnetic influences and other potential sources of interference including engines and VHF radio waves. To ensure optimum operation it is essential to locate the compass correctly.

2.2 General cabling guidelines

- Do not mix ac and dc cables.
- Adhere to EMC guidelines (see *page 7*).
- Use Copex conduit where appropriate to protect cables.
- Label all cables for easy identification
- Keep the Fluxgate compass cable separate from other cables.

Power cable requirement

An overview of the power cables is given in the following illustration.



CAUTION: Power cable

Using an incorrect size of power cable could reduce the power supplied to the drive unit and therefore cause your SPX-5 Tiller system to malfunction. Ensure the correct cable size is used. If in doubt, use a heavier gauge cable.

The requirement for power cables depends on the total length of the power circuit. That is the total length of Cable A + Cable B + Cable C.

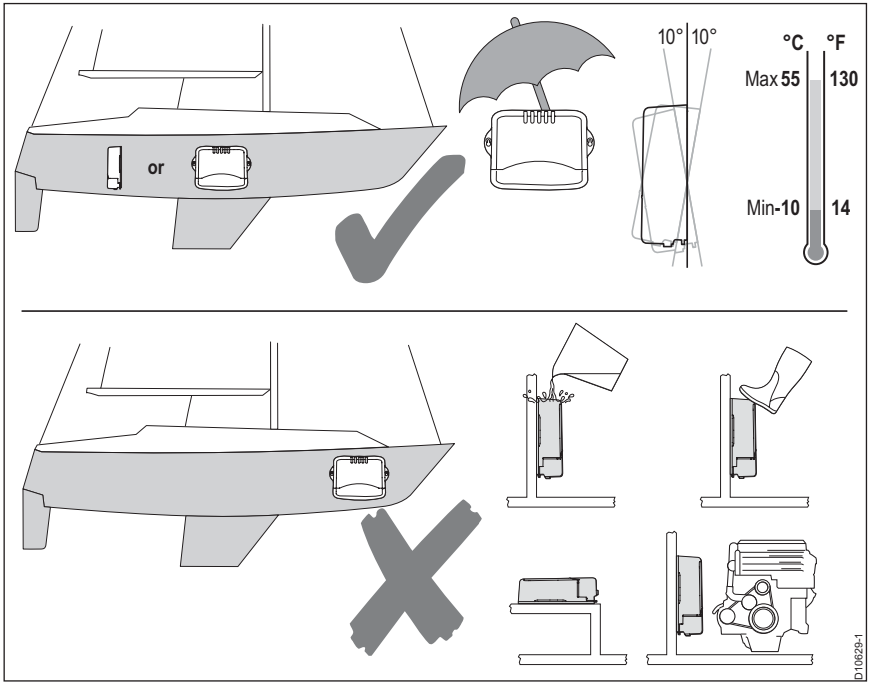
The correct cable dimensions for various cable lengths are given in the following table.

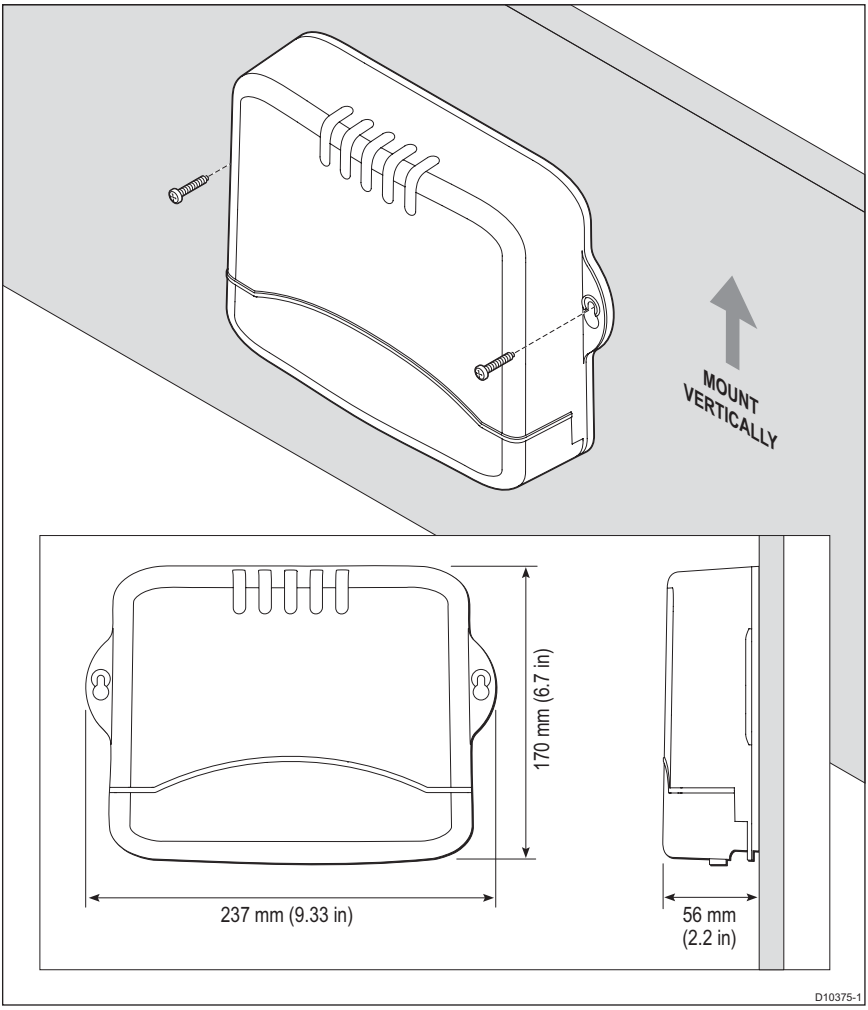
Total cable length (A + B + C)	Copper area	AWG
Up to 2.5 m (8 ft)	1.0 mm^2	18
Up to 4.0 m (13 ft)	1.5 mm^2	16
Up to 6.0 m (22 ft)	2.5 mm^2	14

2.3 SPX-5 Tiller system Course Computer

Mounting

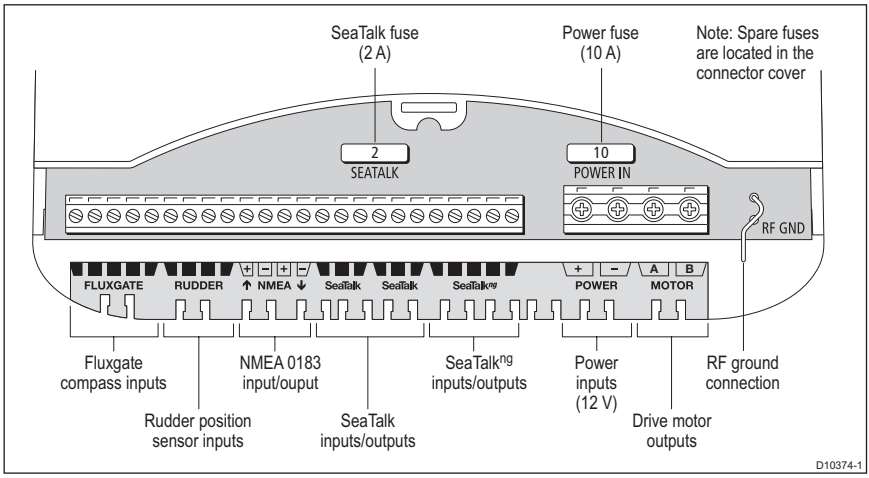
The Course Computer must be mounted on a secure vertical surface, free from vibration.




MOUNT
VERTICALLY
170 mm (6.7 in)
237 mm (9.33 in)
56 mm
(2.2 in)
D10375-1

X-5 connection overview

The X-5 course computer provides the following system connections.



2.4 Install the Tiller Drive

Drive type

The correct Tiller drive unit type is dependent on the fully laden displacement of the vessel.

- For vessels up to 6 tonnes fully laden displacement, use the standard tiller drive.
- For vessels up to 7.5 tonnes fully laden displacement, use the GP tiller drive.

Note: *The actual laden displacement for a vessel can be up to 20% greater than the manufacturer's published displacement figures.*

Mounting requirements

The Tiller Drive must be mounted:

- Horizontally
- So that when the tiller is centered, the drive axis is at 90 degrees to the tiller axis.

Drive unit position

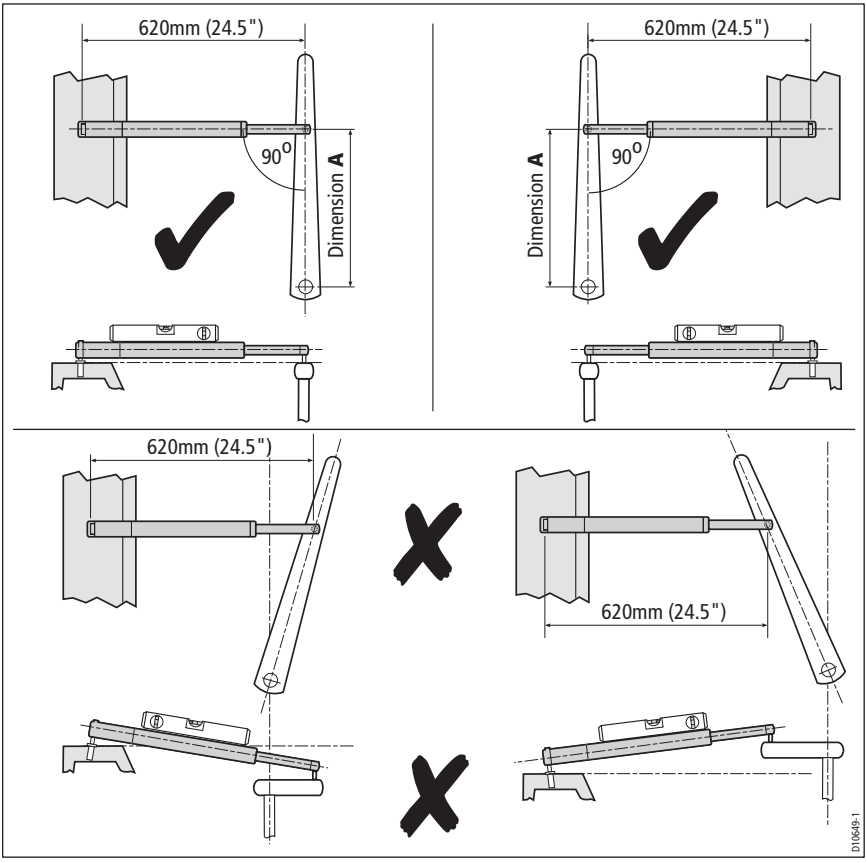
The tiller pin and drive socket can be mounted between 356 mm and 457 mm (14" - 18") from the centre of the rudder stock.

For quicker rudder response in vessels requiring faster turn rates (e.g. lighter displacement vessels), install the tiller pin and drive pedestal closer to the rudder stock, to a minimum of 356 mm (14").

Use the following table to determine the required position for your vessel.

Drive pin distance from rudder stock	Max degrees of helm (with pilot engaged)	Rate of helm change	Force at rudder
457 mm (18”) standard distance	31º	8 º per second	84 kgf
432 mm (17”)	33º	8 º per second	79 kgf
406 mm (16”)	35º	9 º per second	75 kgf
381 mm (15”)	37º	9 º per second	70 kgf
356 mm (14”)	39º	10 º per second	65 kgf

The Tiller drive mounting arrangement is shown in the following illustration. In the following, dimension **A** represents the required distance between the tiller pin and the center of the rudder stock, as determined from the above information.

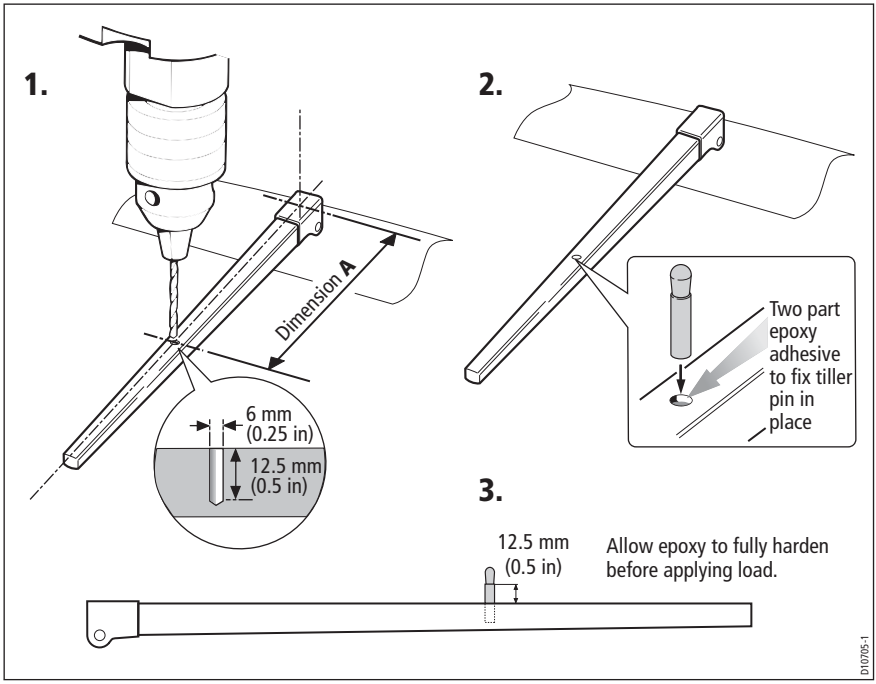


If you need to adapt the standard installation, refer to *Adapting the installation* on *page 16* for adaptation options.

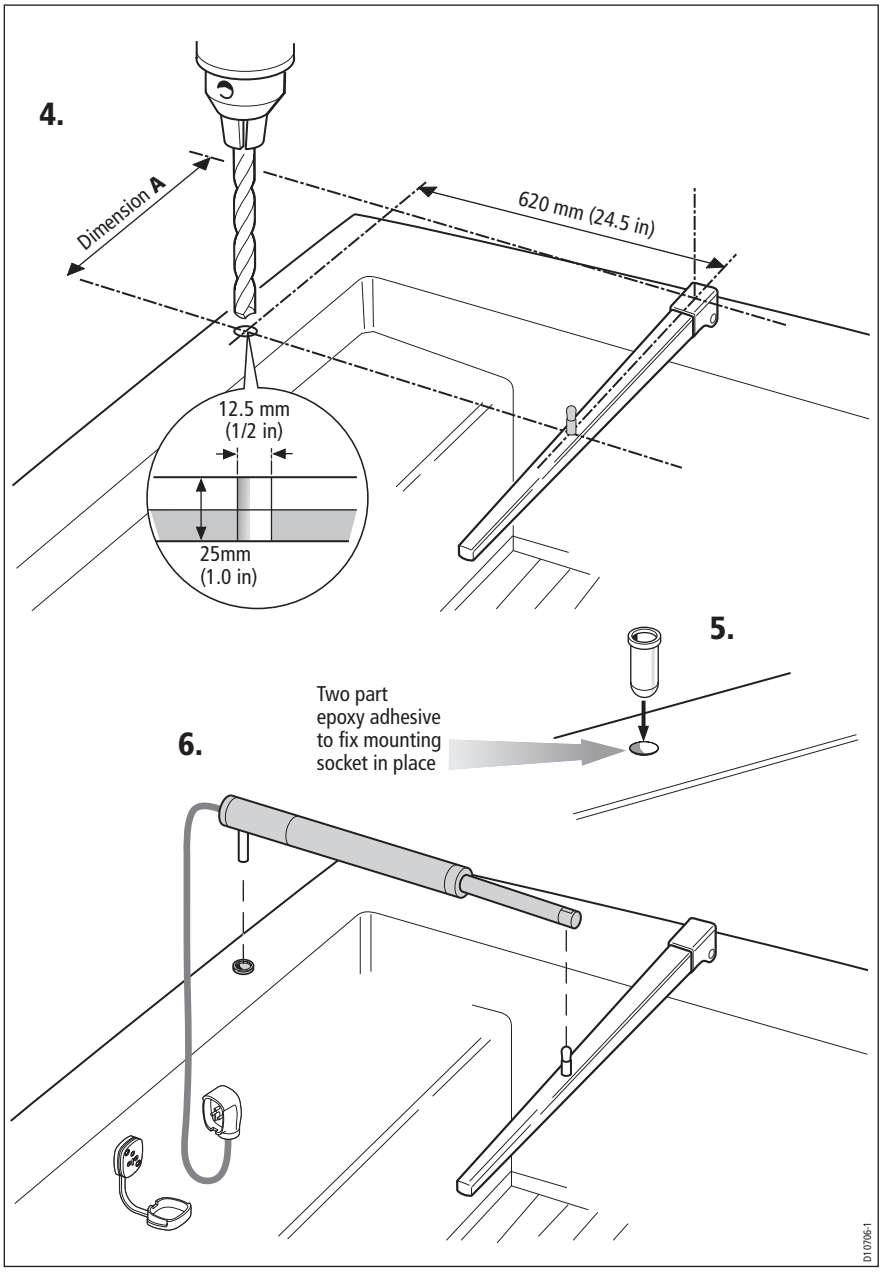
Step 1 - Mount the Tiller Drive

Use this procedure when neither accessories or adaptation of the drive unit position are required.

1. Securely clamp the tiller, mark the pin position and drill the 6 mm (1/4”) hole.
2. Fix the pin in position using a two-part epoxy adhesive.
3. Check the shoulder height of the pin.



4. Mark the socket position and drill a 6 mm (1/4“) pilot hole to check the thickness of the structure. If this is less than 25 mm, reinforce with plywood and bond into position. Once this has cured, open up the hole diameter to 12.5 mm (1/2”).
5. Fix the socket in position using a two-part epoxy adhesive.
6. Once the epoxy has fully hardened, fit the tiller drive


4.
Dimension A
620 mm (24.5 in)
12.5 mm
(1/2 in)
25mm
(1.0 in)
5.
Two part
epoxy adhesive
to fix mounting
socket in place
6.
D10706-1

Step 2 - Install the socket

Cable requirement

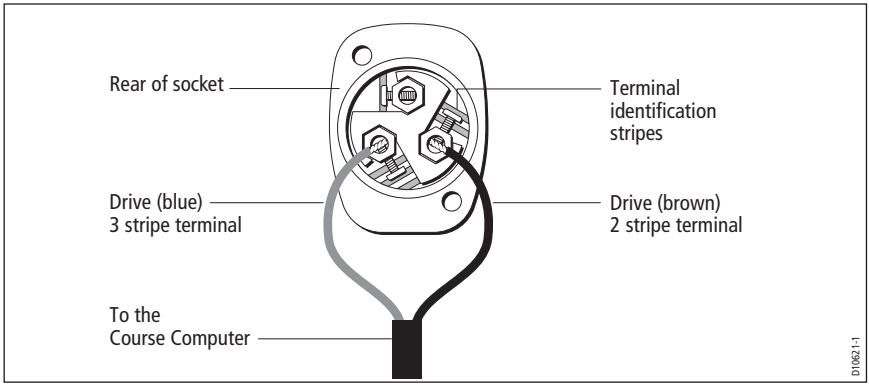
CAUTION: Power cable

Using an incorrect size of power cable could cause your SPX-5 Tiller system to malfunction and reduce the power supplied to the drive unit. Ensure the correct size is used. If in doubt, use a heavier gauge cable.

Measure the distance between the intended location of the Tiller Drive socket and the Course Computer, then use the information under *Power cable requirement* on *page 8*, to determine the correct cable to use to connect power, from the Course Computer to the Tiller drive.

Fitting socket

1. Cut-out and tape the template supplied at the end of this book, to the bulkhead in the required position.
2. Drill a 18 mm ($^{23}/_{32}$") clearance hole and two 2.5 mm ($^{3}/_{32}$") pilot holes.
3. Lift off the template and remove any burrs or sharp edges.
4. Obtain a suitable length of cable as described above and feed one end through the 18 mm hole in the bulkhead.
5. Connect each wire to the correct terminal on the socket, as in the following illustration.



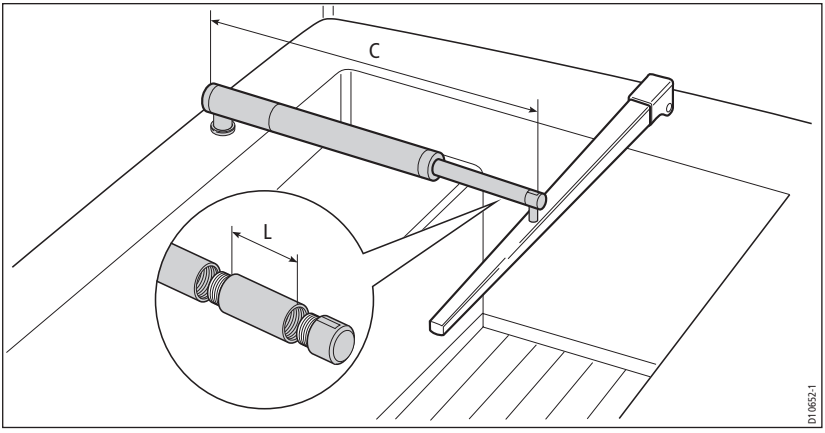
6. Using the two self-tapping screws, secure the socket to the bulkhead.
7. Route the free end of the cable to the Course Computer. Secure the cable as necessary at regular intervals along the route.

2.5 Adapting the installation

Note: *Refer to Accessories on page 5 for details of parts available to adapt your installation.*

Pushrod extension

Referring to the following illustration, if dimension C is greater than 620 mm (24.5”), use a pushrod extension.



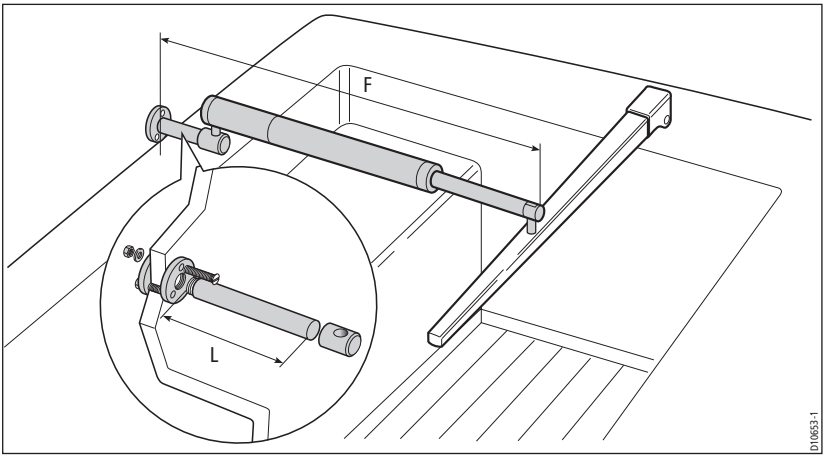
To use a pushrod extension:

1. Select a pushrod extension with a length L nearest to C - 620 mm (24.5”).
2. Unscrew the pushrod end cap.
3. Screw on the pushrod extension.
4. Screw the pushrod end cap onto the pushrod extension.

Pushrod mounting

Cantilever socket

Use the cantilever socket if you need to attach the tiller drive to a vertical face such as the cockpit sidewall.



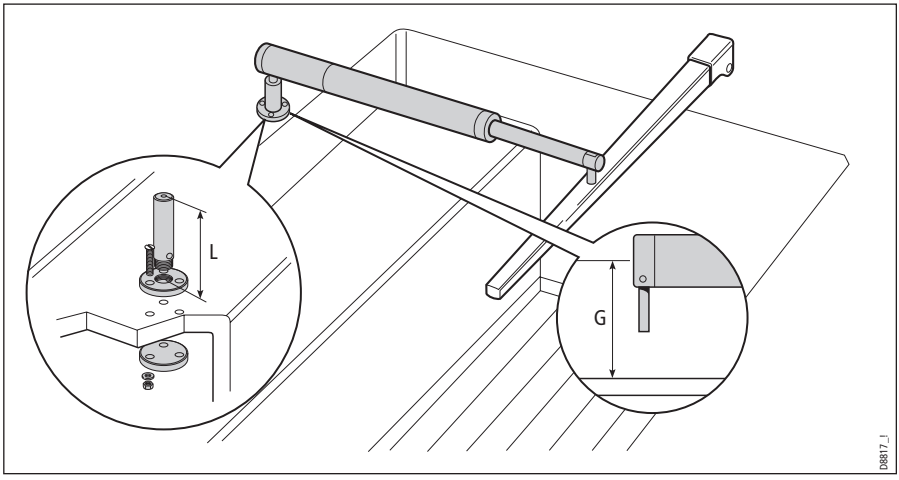
To use the cantilever socket:

1. Use a hacksaw to cut the rod to length L = F - 635 mm (25”).
2. Assemble the mounting ring, rod and socket.
3. With the drive horizontal mark the location of the mounting ring and its holes.
4. Drill three 6 mm (1/4”) diameter clearance holes at the marked positions.
5. Apply a thin coat of silicone sealant to the base of the mounting ring.
6. Use three 6 mm (1/4”) diameter bolts, nuts and washers to attach the mounting ring and backing plate
7. Roughen the end of the rod and inside of the socket to provide a key. Then apply two-part epoxy adhesive to the rod end and cap.
8. Place the cap over the rod end, making sure the hole faces upwards. Allow the adhesive to harden fully before applying a load.

Note: *Note: When the autopilot is not in use, you can unscrew the complete rod assembly to leave the cockpit unobstructed*

Pedestal socket

Use the pedestal socket if you need to raise the height of the socket to make the tiller drive horizontal.



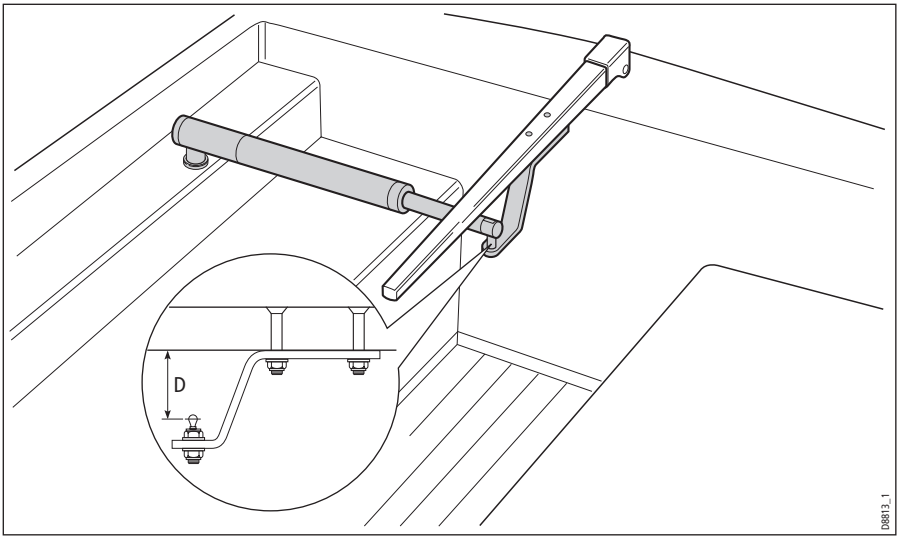
To use a pedestal socket:

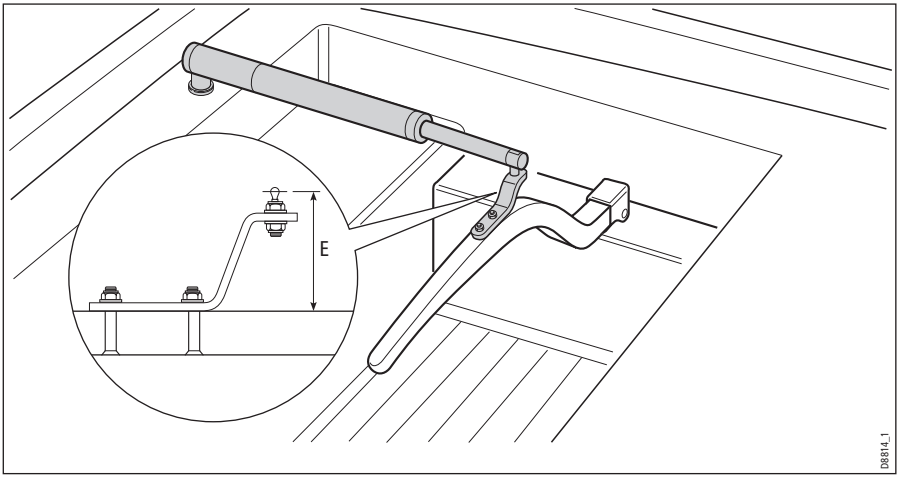
1. Select a socket assembly with a length L, nearest to G -38 mm (1.5”).
2. With the drive assembled, and the socket positioned 460 mm (24.5”) from the tiller axis mark the location of the mounting ring and holes.
3. Drill three 6 mm (1/4”) diameter clearance holes at the marked positions.
4. Apply a thin coat of silicone sealant to the base of the mounting ring.
5. Use three 6 mm (1/4”) diameter bolts, nuts and washers to attach the mounting ring and backing plate

Note: *Note: When the autopilot is not in use, you can unscrew the complete rod assembly to leave the cockpit unobstructed*

Tiller brackets

If the tiller is higher or lower than the mounting socket, use a tiller bracket to vary the tiller pin height so the drive is horizontal.





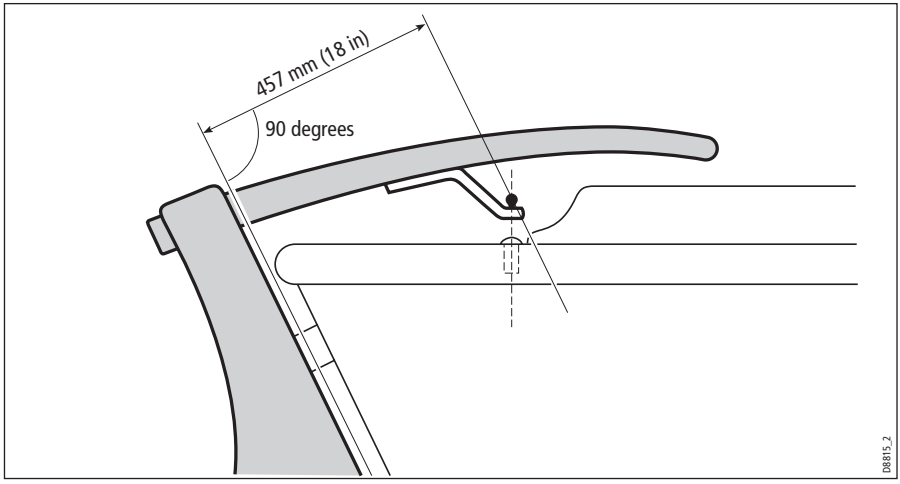
If the drive is below the tiller, bracket size equals dimension D.

If the drive is above the tiller; bracket size equals dimension E - 25 mm (1”).

To use a tiller bracket:

1. Place the tiller bracket on the center line of the tiller (above or below) and establish the correct position.
2. Mark the centers of the bracket mounting holes.

3. Drill two 6 mm (1/4”) diameter clearance holes through the center line of the tiller at the positions marked.
4. Attach the tiller bracket using two 6 mm (1/4“) diameter bolts, nuts and washers.
5. Fix the bolts in position using two-part epoxy adhesive.
6. When the epoxy is completely hardened, fully tighten the nuts.



2.6 Connecting power & drive cables to the Course Computer

Power supply

The SPX-5 Tiller system needs a 12 V dc supply.

CAUTION: Ensure correct supply voltage

Do NOT connect 24 V to the Course Computer, or damage to the product could occur.

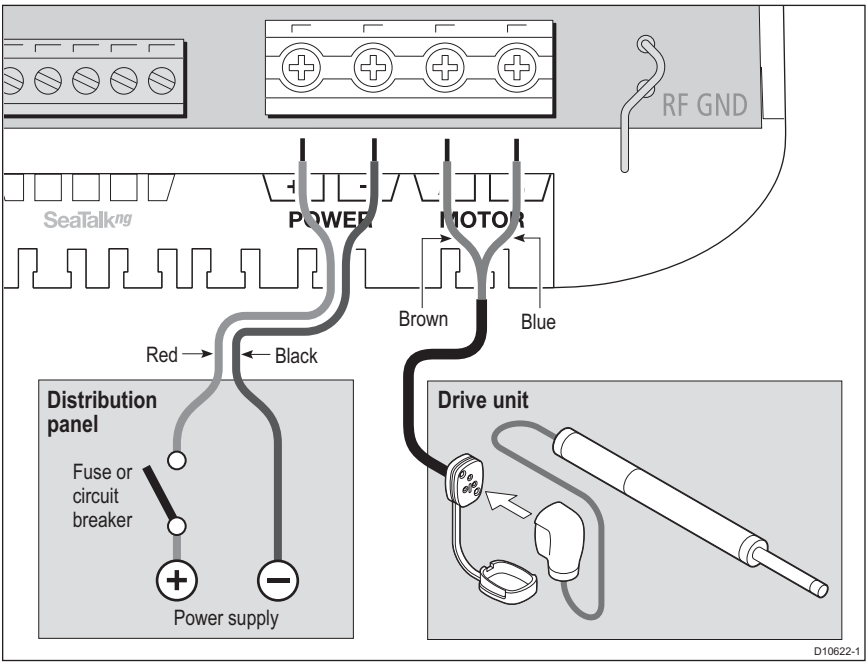
Circuit breaker/fuse

Protect the power supply for the SPX-5 Tiller system with a 10 A fuse or circuit breaker.

Cable

Using the information given at *Power cable requirement* on *page 8*, obtain the required length of the appropriate cable to connect power from the boat’s distribution panel to the Course Computer.

Connection procedure



At the Course Computer, locate the free ends of the power cable from the distribution panel and Tiller Drive cable. Ensuring all power is switched off, refer to the following illustration and connect each cable to the correct Course Computer terminals as follows:

1. Strip 8-10 mm (1/2 inch) of insulation from the end of each wire.
2. Use a small screwdriver to loosen the relevant screws on the terminal block.
3. Insert the stripped wires into the appropriate terminals and tighten the screw.

2.7 Fluxgate compass

Note: *If you intend using a separate NMEA compass, do not connect the Fluxgate Compass supplied with your X-5 Tiller system. Instead, connect the NMEA compass to the NMEA input on the SPX-5 Tiller system.*

Use these instructions to install the Fluxgate Compass.

After fitting the Fluxgate Compass, ensure you affix the compass safe area label adjacent to the Fluxgate Compass.

The compass contains a self-levelling mechanism. This enables the compass to provide accurate readings with pitch and roll movements up to +/- 35°.

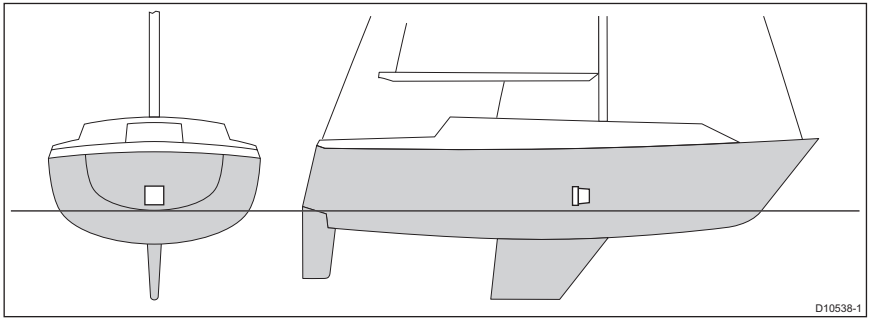
Note: *When shaken, the Fluxgate Compass makes a rattling sound. This is entirely normal and is not a cause for concern.*

Compass mounting

Location

To achieve the best performance, mount your compass:

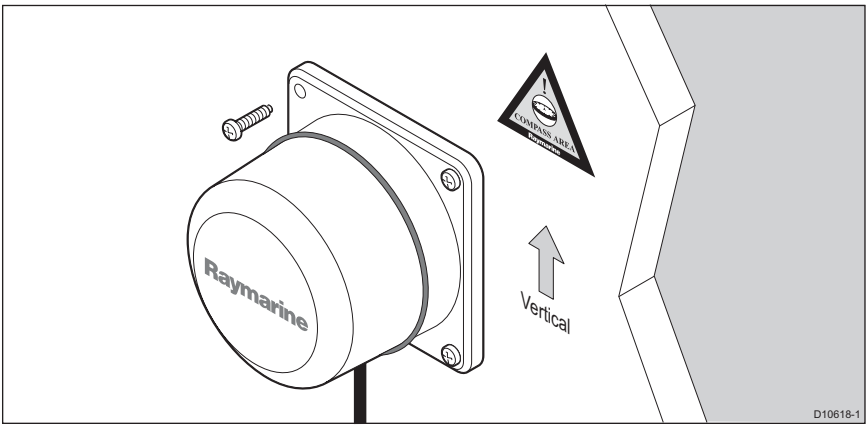
- With the Raymarine logo facing the bow.
- As close as possible to the boat's pitch and roll center.
- At least 2ft 6 in (0.8 m) away from your boat's steering compass to avoid deviation of both compasses.
- As far away as possible from large iron masses, such as the engine or other magnetic devices.



Note: *To check if the intended mounting location is free from magnetic influence, tape a hand-held compass to the chosen location, then turn the boat through 360°. The readings on the hand-held compass and your boat's main steering compass (if accurately aligned) should not differ by more than10° at any heading.*

Mounting procedure

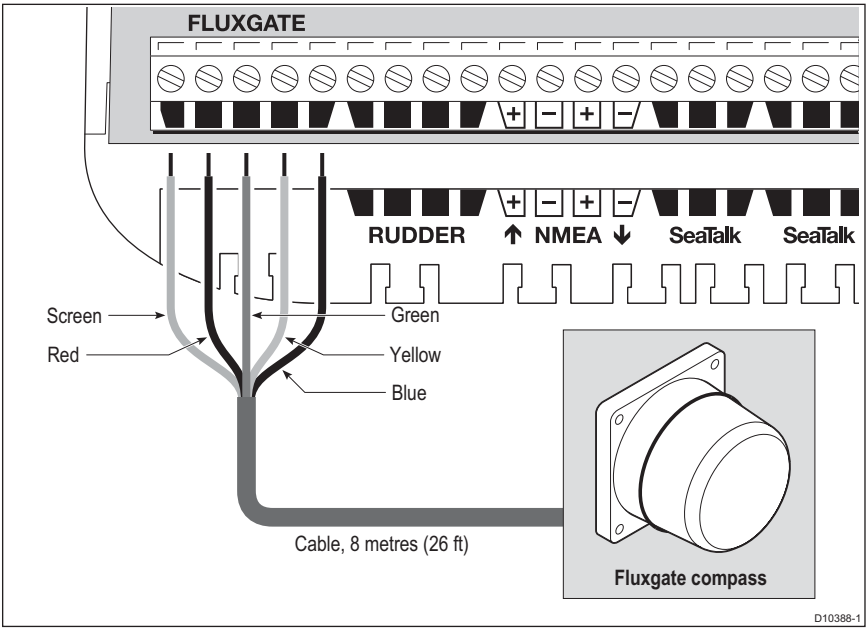
1. Mount the Fluxgate Compass on a vertical bulkhead, with the cable leaving at the bottom of the unit.
2. Stick the supplied warning label near to the compass, where it is clearly visible.



Compass connection

Route the compass cable to the Course Computer, securing it at regular intervals with suitable cable clips/ties.

Connect to the Course Computer as in the following illustration.



2.8 Pilot Controller

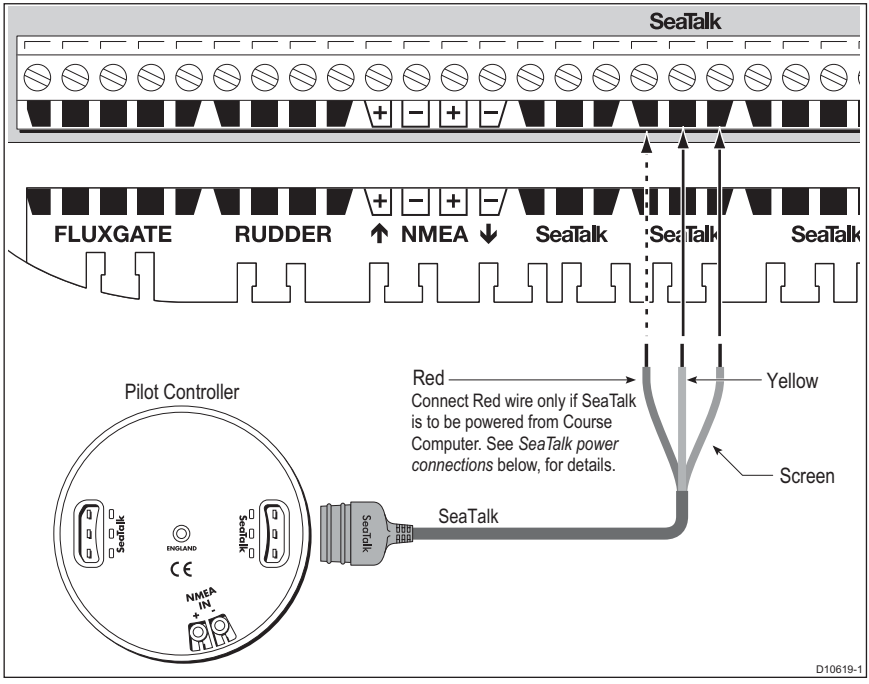
Fitting

The ST6002 Pilot Controller is supplied with an 9 m cable for connection to the SeaTalk bus. Ensure that your mounting location is within 9 m of a suitable connection point. You may purchase a longer cable if required.

Fit the controller in accordance with the separate instruction leaflet.

Connecting to SeaTalk

The Pilot Controller connects to SeaTalk at the Course Computer, as shown in following diagram.



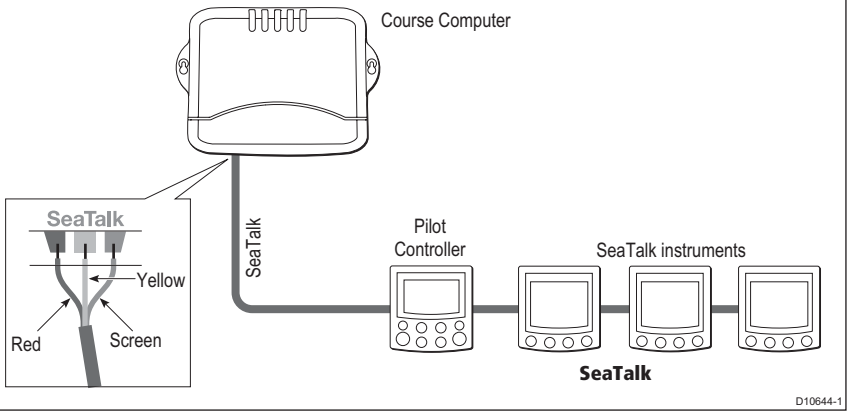
Note: *You will need an additional cable to connect your controller to an existing SeaTalk instrument*

SeaTalk power connections

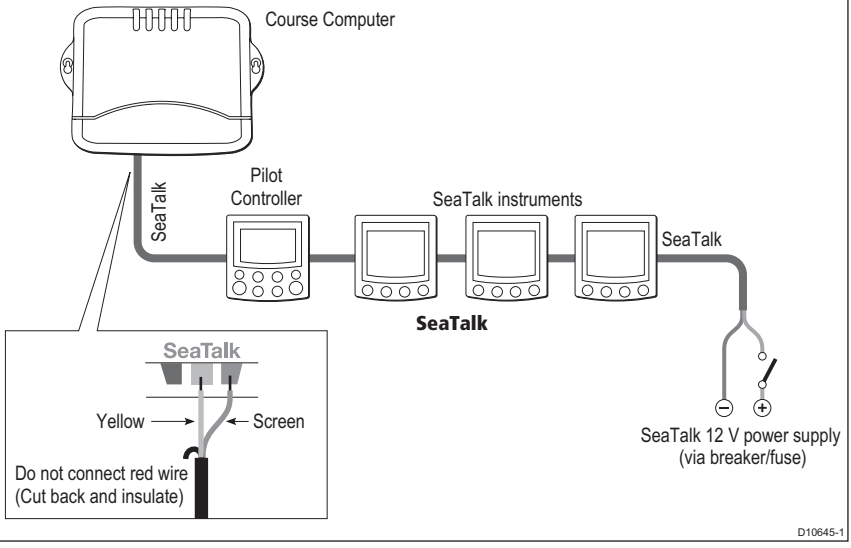
The exact manner in which connections are made depends on how power is supplied to SeaTalk:

- If power is supplied by the Course Computer, connect the red and yellow wires and the screen to the Course Computer.
- If power is supplied from an external source, connect only the yellow wire and the screen to the Course Computer. Do NOT connect the red wire.

SeaTalk power supplied by Course Computer



SeaTalk power supplied externally



2.9 Connect to ground

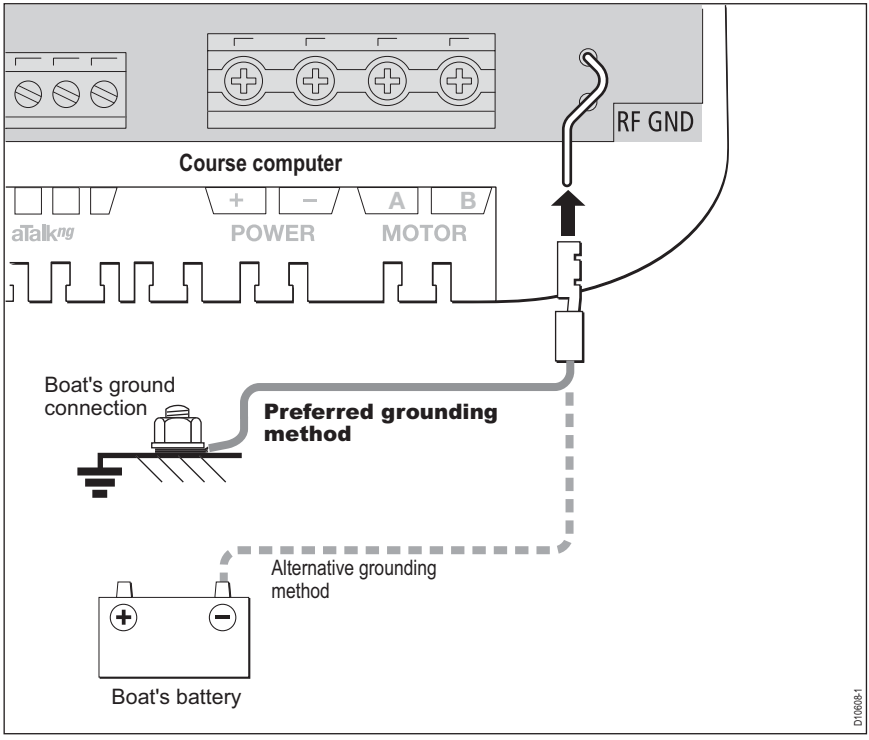
CAUTION: Grounding

SPX-5 Tiller system ground MUST be connected to ship's ground. Failure to connect to ship's ground may cause it, or other on-board electronics to malfunction.

To ground your SPX-5 Tiller system:

- Use a dedicated earthing plate (e.g. dynaplate) in contact with the water.
- Use flat tinned copper braid, 30 A rating (1/4 inch) or greater. Equivalent stranded wire diameter 4mm or greater
- Keep the length of the earth braid as short as possible.

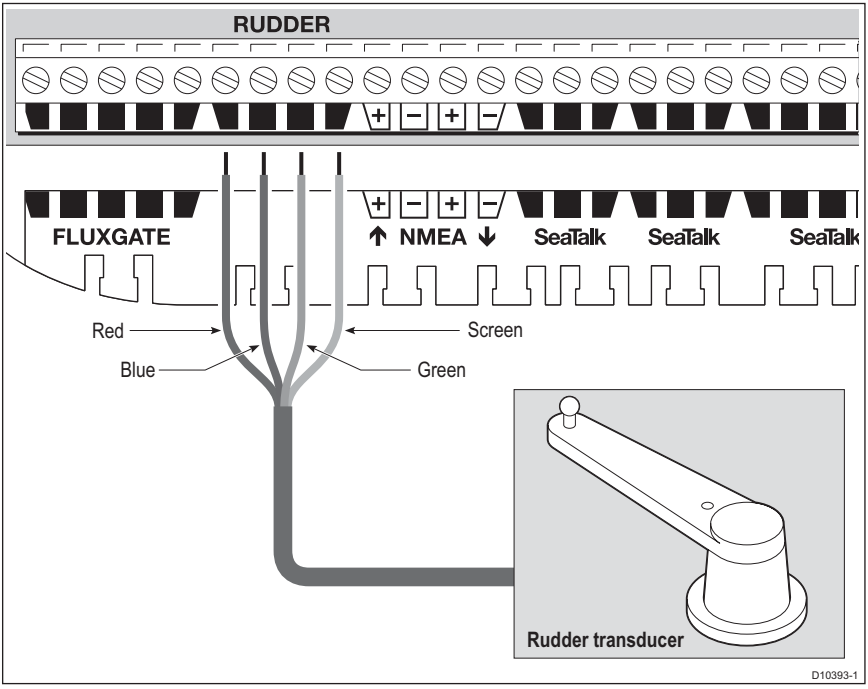
Note: *If you cannot connect to a dedicated earthing plate you may connect ground to the negative pole of the battery (ideally at the battery itself).*



2.10Optional connections

Rudder reference

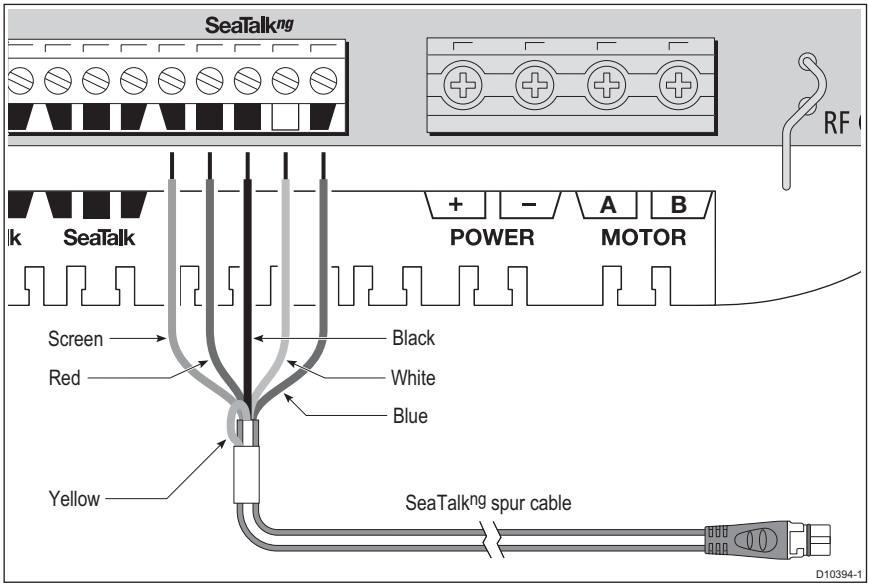
An optional rudder reference transducer is available to provide an accurate display of the rudder angle. If you have the optional rudder reference transducer, connect it to the course computer as shown.



SeaTalk^{ng} Connections

To connect your autopilot to a SeaTalk^{ng} backbone, use a dedicated spur cable. Spur cables are available from your Raymarine dealer, as follows:

SeaTalk^{ng} spur cable length	Part number
1 ft 3 in (400 mm)	A06038,
3 ft 3 in (1 m)	A06039
9 ft 10 in (3 m)	A06040
16 ft 4 in (5 m)	A06041



SeaTalk^{ng} power

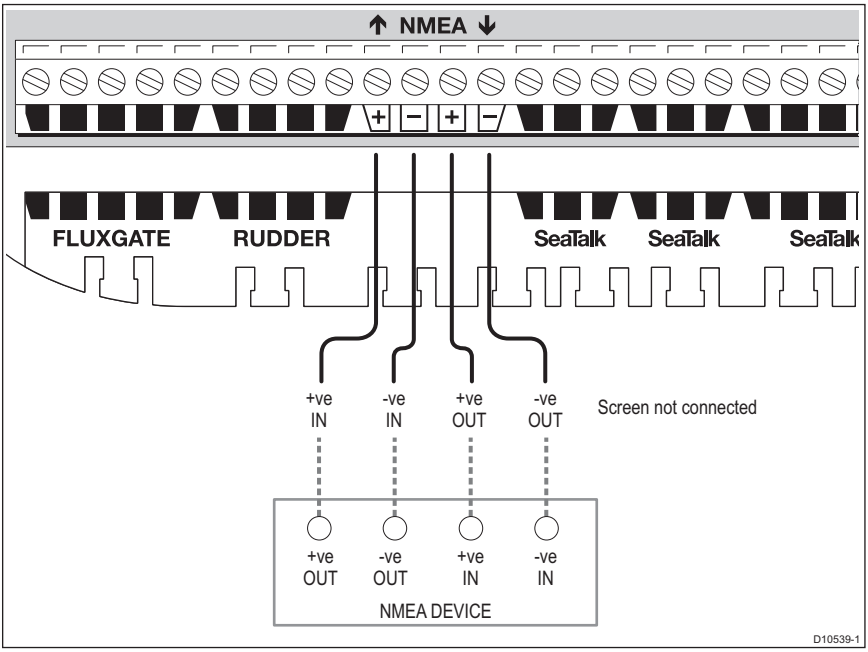
The Course Computer does NOT supply power for SeaTalk^{ng}. A SeaTalk^{ng} system must be powered from its own separate power supply.

See also

For more information on SeaTalk^{ng} systems refer to the *SeaTalk^{ng} Reference Manual* available from the Raymarine web site. www.raymarine.com/handbooks.

NMEA 0183 equipment

The SPX-5 Tiller system can connect to NMEA devices such as a GPS or chartplotter.



Data bridging

The SPX-5 Tiller system acts as a bridge between SeaTalk and NMEA, allowing NMEA and SeaTalk devices to share information.

For example, the information received from an NMEA GPS could be shared with a SeaTalk instrument to provide a separate Course Over Ground display.

NMEA 0183 / Connecting other manufacturers' equipment

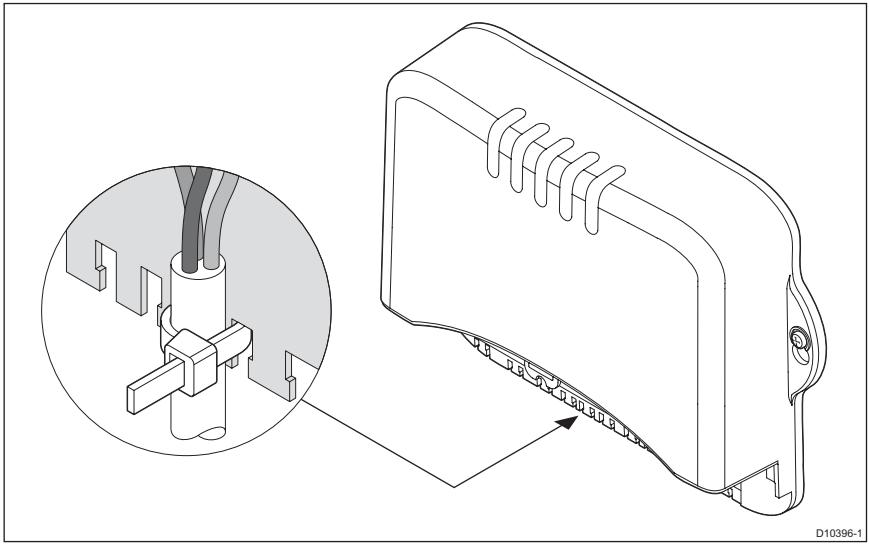
- When connecting Raymarine equipment to other equipment using a non-Raymarine cable, you MUST attach an appropriate suppression ferrite to the cable near to the Raymarine unit.
- When connecting third party equipment refer to the manufacturer's instructions for cable details.
- You should not connect more than one piece of equipment to the Course Computer NMEA input.

2.11Final checks

When you have completed all necessary installation procedures, but before you apply power to the system, ensure all equipment and connections are properly secured.

Secure all cables

To prevent strain on the connector blocks, secure the cables to the Course Computer with cable ties as shown below.



2.12Commission the system before use

The SPX-5 Tiller system must be commissioned prior to use, in accordance with the instructions in *Chapter 3: Commissioning & setup*. For new systems this involves calibrating the system, which is a **safety-critical action**.

Chapter 3: Commissioning & setup

This chapter describes the commissioning and setup procedures for your Raymarine SPX-5 Tiller system.

Requirement

The commissioning procedures are mandatory and must be carried out after installation, before the SPX-5 Tiller system is used to steer the boat.

Additional setup procedures are also provided for you to fine tune your SPX-5 Tiller system for optimum performance with your boat. They are not mandatory and you may find that you do not need to use them if the SPX-5 Tiller system operates to your satisfaction after commissioning.

When commissioning and setting up the SPX-5 Tiller system, use the supplied ST6002 controller (Pilot Controller):

- **standby** & **auto** select the required operating mode.
- **+1, -1, +10** & **-10** initiate course changes.
- **disp** & **track** provide access to extended functions.

Note: *The system is also compatible with ST7002, ST8002 and ST70 Pilot Controllers*

3.1 Commissioning

The commissioning process comprises:

- Dockside checks &setup.
- Seatrial calibration.

Dockside checks & setup

The dockside checks comprise:

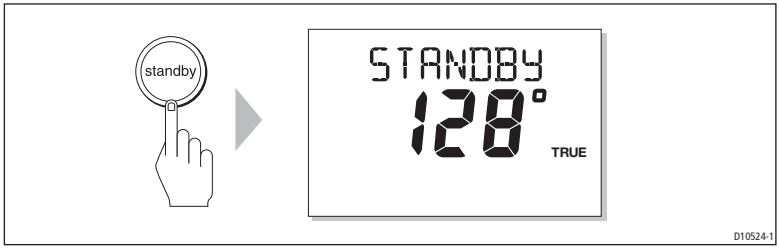
1. Switching on.
2. Checking SeaTalk and NMEA 0183 connections.
3. Checking autopilot steering sense.
4. Setting vessel type and drive type
5. Setting rudder limits, if rudder reference option fitted.

With the boat safely tied up, carry out the dockside checks and setup procedures before any trials at sea or other setup procedures.

Switching on

1. Observing the Tiller drive unit, switch on the main power breaker. If the Tiller drive moves, switch off the power immediately, then ensure the system wiring is correct
2. When the Pilot Controller and Course Computer are powered up, the controller. will beep and show the controller type for a few seconds, before showing the **STANDBY** screen.

   A **CALIBRATE REQUIRED** message may be displayed. This indicates that the autopilot commissioning is not yet complete.
3. Check that the **STANDBY** screen displays a live compass heading.



Check SeaTalk and NMEA 0183 connections

SeaTalk instruments

If you have connected the Pilot Controller to other SeaTalk instruments or controllers:

1. Select display lighting level 3 (**LAMP 3**) on one of the other SeaTalk instruments or controllers.
2. Check that the Pilot Controller display lights are on. If the lights are not on, check the SeaTalk cabling between the Pilot Controller and the other units.

SeaTalk and NMEA GPS or Chartplotter

If you have connected the SPX-5 Tiller system to a chartplotter or GPS (e.g. via NMEA0183 or SeaTalk), check the links by displaying the default navigation data pages on the Pilot Controller. To do this:

1. Press **disp** to display the first data page (**XTE**), and check that this page shows the expected data.
2. Press **disp** again to check each successive data page (**BTW**, **DTW** etc).

If the display shows dashes instead of expected data values, ensure:

- The GPS or chartplotter is switched on and transmitting an active waypoint.
- The GPS or chartplotter is configured to transmit the required data format.
- There is not a cabling error. Check for open circuit, short circuit or reversed connections.

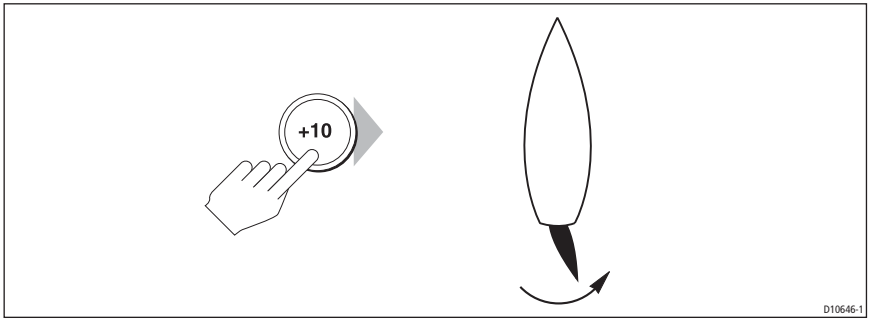
Other NMEA 0183 connections

To check other NMEA connections, you will need to set up the appropriate page of data using Display calibration mode. See *page 47*.

For details of supported NMEA sentences, see *Appendix 1: NMEA 0183 sentences*.

Checking autopilot operating sense

1. Manually center the tiller, then press auto (so the SPX-5 Tiller system is in Auto mode), then check that the display shows **AUTO**.
   Be ready to press **standby** if the rudder moves hard over**.**
2. Press +10 once.
3. Check that the rudder moves to starboard a few degrees and then stops.
   If the rudder drives hard over, immediately press standby to prevent further rudder movement.



4. If the rudder moves to port or the rudder drives hard over:
   i. Press **standby.**
   ii. Turn off the power.
   iii. Reverse the motor wires connected to the SPX-5 Tiller system computer.
   iv. Switch on the power and re-check.

Note: *If the rudder overshoots and has to drive back or starts to hunt back and forth, increase the rudder damping level manually (See page 54).*

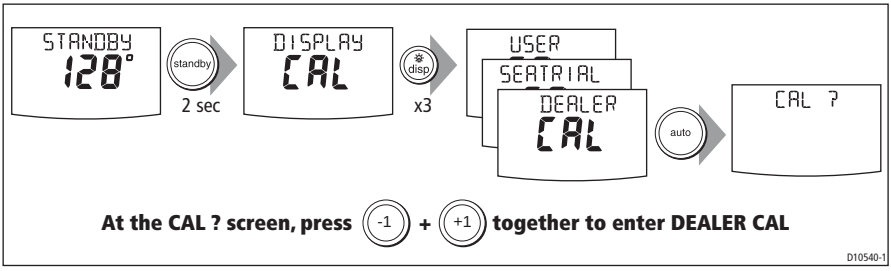
Setting the vessel and drive type

in order to set up the vessel type and drive type, you need to enter the Dealer calibration mode.

WARNING: Use Dealer calibration correctly
Improper use of Dealer calibration can seriously impair SPX-5 Tiller system performance and therefore adversely affect the steering capability. Do not change Dealer calibration settings other than as described in the product documentation.

To enter the Dealer calibration mode:

1. Ensure the autopilot is in Standby mode.
2. Hold down standby for two seconds to enter the Calibration mode.
3. When the screen shows **DISPLAY CAL**, press disp until the **DEALER CAL** screen is displayed.
4. Press auto. The display will change to **CAL?**.
5. Press **-1** and **+1** together to enter Dealer calibration.



Set the vessel type

When you select a vessel type, the SPX-5 Tiller system automatically selects appropriate default values for various other calibration settings. These default values are listed on *page 58*.

To setup the vessel type, enter Dealer calibration then:

1. Use disp to scroll through the Dealer calibration pages until the display shows either **VESSEL** or one of the vessel types (e.g. **DISPLACE**).
2. Use -1 or +1 to select **SAIL BOAT**:
3. Press disp to confirm the selection and move to the drive type option.

Set the drive type

1. With the SPX-5 Tiller system still in Dealer calibration, use disp to scroll through the calibration pages until you reach the **DRIVE TYP** page.
2. Use -1 or +1 to select drive type **3**.
3. Press disp to confirm the selection and move to the next calibration option.

Align the rudder indicator

Carry out this procedure only if the rudder reference option is fitted. If the rudder reference option is not fitted, ignore this procedure.

If the rudder reference option is fitted:

1. With the SmartPilot still in Dealer Calibration, press disp to scroll through the calibration pages until you reach the **ALIGN RUD** page.
2. Use the wheel to center the rudder.
3. Use -1 and +1 to adjust the rudder bar so it is positioned at the center.
   The maximum adjustment available is ±9°. If the offset is beyond these limits, you will need to physically adjust the alignment of the sensor.
4. Press disp to confirm the correct alignment and move to the next calibration option.

Note: *Alternatively, you can zero the rudder bar with the boat underway during the initial seatrial, by manually steering a straight course then accessing the* **ALIGN RUD** *screen in Seatrial Calibration to adjust the offset.*

Set the rudder limits

Carry out this procedure only if the rudder reference option is fitted. If the rudder reference option is not fitted, ignore this procedure.

If the rudder reference option is fitted:

1. With the SmartPilot still in Dealer Calibration press disp to scroll through the calibration pages until you reach the **RUD LIMIT** page.
2. Turn the wheel to move the rudder:
   - To the port end stop and note the angle on the rudder bar
   - To the starboard end stop and note the angle on the rudder bar
3. Use -1, +1, -10 and +10 to set the rudder limit to 5° less than the lowest angle you have noted.
4. Press disp to select the new value and move to the next calibration option.

Save the new settings

When you have adjusted the above settings hold down standby for two seconds, to save your changes, leave Dealer calibration and return to the Standby mode.

Seatrial calibration

When you have completed the dockside checks, carry out a Seatrial calibration, to calibrate the compass and set up the autopilot steering characteristics.

Before commencing the seatrial:

- The dockside calibration must have been successfully completed.
- There must be no EMC problems (see *page 7*).

Important

If you need to return to manual steering at any time during a Seatrial or any other procedure, **press the standby button**. NEVER compromise vessel safety.

Seatrial conditions

The seatrial must be carried out only:

- In conditions of light wind and calm water.
- In waters that are clear of any obstructions, so the boat has plenty of clear space to maneuver.

In order to achieve optimum autopilot performance, course over ground (COG), speed over ground (SOG) and latitude (LAT) data must be available to the SPX-5 Tiller system (e.g. on SeaTalk). Ensure that the equipment providing this information (e.g. GPS), is switched on and fully operational, before starting a Seatrial.

The Seatrial procedures are:

- Compass calibration.
- Using AutoLearn to set the SPX-5 Tiller system steering characteristics.

Compass calibration

The compass calibration procedures are:

- Swinging the compass.
- Aligning the compass.

Swinging the compass

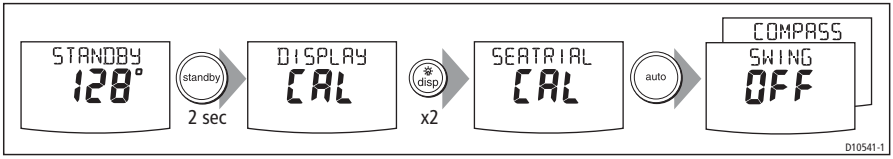
The magnetic deviation correction procedure (commonly called “swinging the compass”) involves turning your boat in slow circles so the autopilot can automatically determine the deviation and apply any correction required. The correction procedure reduces deviation errors to a few degrees.

As magnetic deviation can cause significant compass errors on your boat, you **MUST** complete the compass swing before any other seatrial procedure.

To swing the compass:

1. With the pilot in Standby mode, enter Seatrial calibration as follows:
   i. Hold down standby for two seconds to enter Calibration mode.
   ii. When you see the **DISPLAY CAL** screen, press disp until you see the **SEATRIAL CAL** screen.
   iii. Press auto to enter Seatrial calibration.

2. Use disp to move through the Seatrial calibration items until you see **SWING COMPASS**.



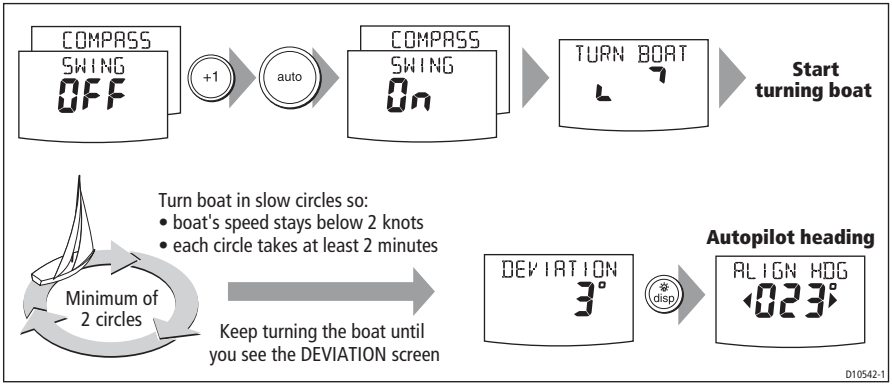
Note: *If you cannot access Seatrial calibration, you need to disable the calibration lock. This can be found in Dealer calibration (see page 52).*

3. When you are ready to start, press +1, to select **SWING COMPASS ON**.
4. Press auto to start the compass swing.
   The Pilot Controller will display **TURN BOAT**.
5. Start slowly turning the boat in circles (keeping the boat's speed below 2 knots). You will need to complete at least two circles, taking at least 2 minutes to complete each 360°:
   If you turn the boat too quickly, the display will show a **TOO FAST** message. If this occurs, **apply less helm to turn in a larger circle.**

Note: *If necessary, you can quit the correction process by pressing **standby** or **disp**. If you then want to repeat the deviation correction, return to the* **SWING COMPASS** *screen.*

6. Continue slowly turning the boat until the controller beeps and displays the **DEVIATION** screen. This indicates that the SPX-5 Tiller system has completed the deviation correction.

Note: *This screen shows the maximum deviation encountered over 360° (not as an east/west value).*



If the deviation figure exceeds 15° or the display shows no deviation value, the compass is being affected by ferrous objects on your boat. You should move the compass to a better location. Higher deviation figures are acceptable on steel boats.

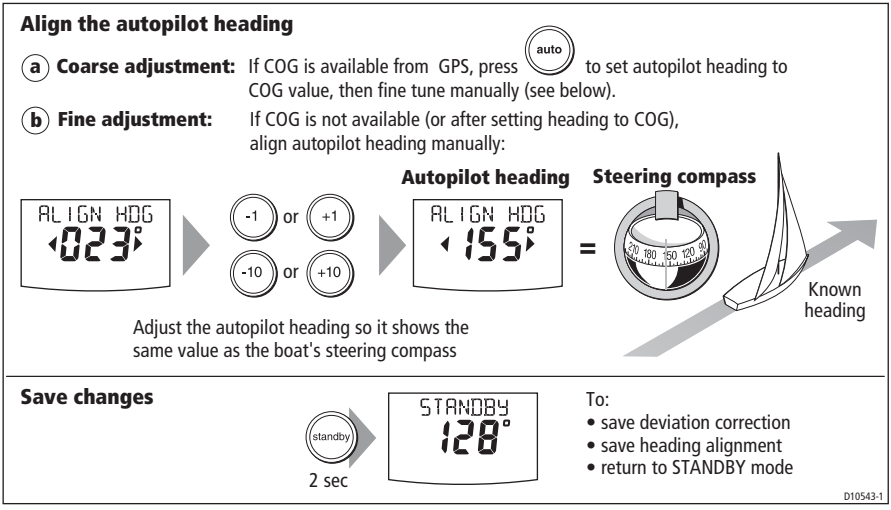
Aligning the compass heading

Once the deviation is displayed, press **disp** to move to the Heading Alignment (**ALIGN HDG**) page, then:

1. Manually steer the boat on a steady course at a speed sufficient to hold the course.
2. If you have a GPS connected to your SPX-5 Tiller system:
   i. Increase the boat speed to more than 3 knots
   ii. Press auto. The SPX-5 Tiller system will then set the heading to agree with the COG (course over ground) heading received from the GPS

As many factors can cause a difference between heading and COG you must then fine-tune the heading alignment so it matches the boat's steering compass (or a known transit bearing) To do this:

1. Use -1, +1, -10 and +10 to adjust the displayed heading until it matches boat's steering compass (or a known transit bearing).
2. Hold down standby for 2 seconds to exit Seatrial calibration and save the new compass settings.


Align the autopilot heading
a Coarse adjustment: If COG is available from GPS, press auto to set autopilot heading to COG value, then fine tune manually (see below).
b Fine adjustment: If COG is not available (or after setting heading to COG), align autopilot heading manually:
Autopilot heading
Steering compass
ALIGN HDG
023°
-1 or +1
-10 or +10
ALIGN HDG
155°
=
Known heading
Adjust the autopilot heading so it shows the same value as the boat's steering compass
Save changes
standby
2 sec
STANDBY
128°
To:
• save deviation correction
• save heading alignment
• return to STANDBY mode
D10543-1

Although the compass calibration removes most of the alignment error, small errors (a few degrees) may remain. Once you have completed the initial compass calibration, you can make further adjustments to the alignment without having to swing the compass again.

Check the heading reading against a number of known headings, plot a deviation curve, and determine the heading alignment value that will give the lowest **average** alignment error. You can then enter this value on the Heading Alignment screen, as described above.

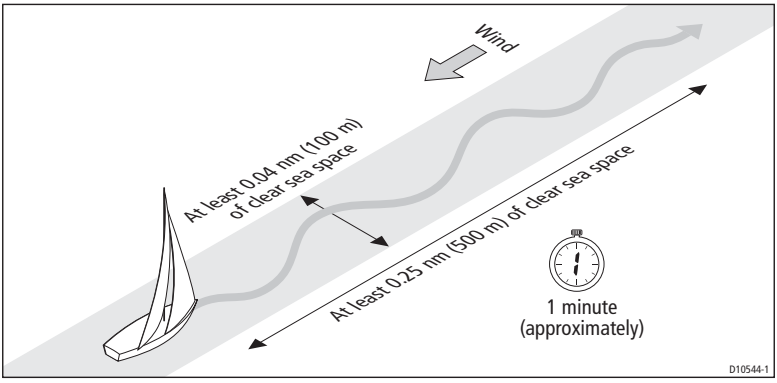
If the average heading error is more than 5°, you should perform the compass deviation correction procedure again, circling more slowly and in more favorable conditions.

AutoLearn

WARNING: Ensure there is enough clear sea space
The AutoLearn process takes the boat through a number of maneuvers, which can result in sudden, sharp turns, especially when the AutoLearn function is run on more maneuverable boats. Therefore, ensure there is a significant amount of CLEAR SEA SPACE in front of the boat, before starting an AutoLearn process.

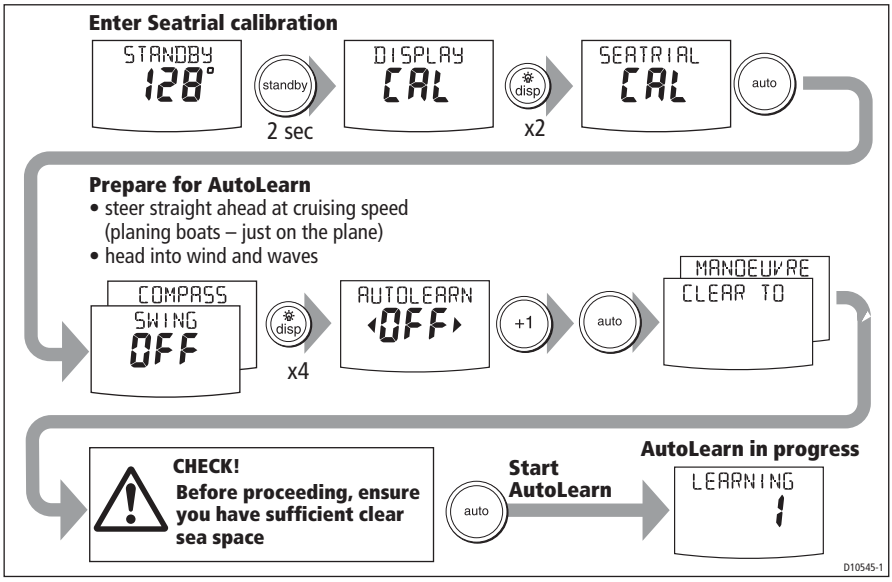
The next stage of the Seatrial is to carry out an AutoLearn routine. AutoLearn is a self-learning calibration feature that automatically adjusts rudder gain, counter rudder and AutoTrim for optimum performance for your boat.

If you need to return to manual steering at any time during an AutoLearn routine or any other procedure, **press the** standby **button**. NEVER compromise vessel safety.



Carry out an AutoLearn as follows:

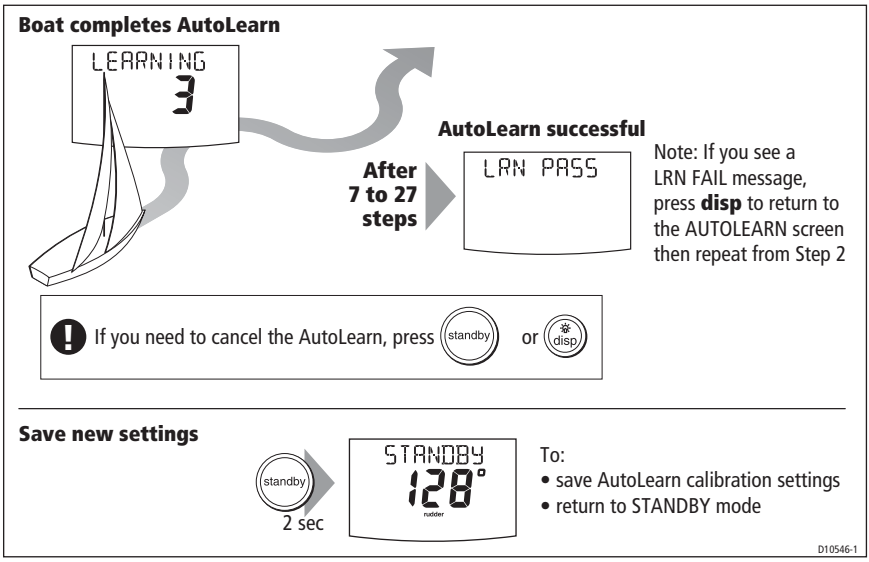
1. Ensure you have sufficient sea room to complete the AutoLearn:
2. Access the **AUTOLEARN** screen in Seatrial calibration:
   i. From Standby mode, hold down standby for 2 seconds, then press disp twice to see the SEATRIAL CAL screen.
   ii. Press auto to enter Seatrial calibration, then press disp four times to see the **AUTOLEARN** screen.
3. Prepare to start the AutoLearn:
   - Steer straight ahead (rudder centered) and motor the boat at typical cruising speed.
   - If conditions are not calm, head into the wind and waves.
4. When you are ready to start the AutoLearn, press +1 then auto**.**



5. The screen will show the **CLEAR TO MANEUVER** message. Ensure it is safe to continue, then press auto to start the AutoLearn maneuvers:
   - The boat will start a series of zig-zag turns and the display will show **LEARNING** with a number to indicate the current AutoLearn stage. This number increases as AutoLearn progresses.
   - A typical AutoLearn completes within 7 to 27 steps (depending on boat characteristics and sea conditions).

Note: *To cancel an AutoLearn, press **standby** or **disp**.*

6. When the SPX-5 Tiller system has finished learning, the controller will beep and display either **LRN PASS** or **LRN FAIL**:
   - **LRN PASS** = AutoLearn completed successfully
   - **LRN FAIL** = AutoLearn was not successful, so should be repeated. A failure code will also be displayed:
     1 = AutoLearn has not been carried out.
     2 = AutoLearn failed, due to manual interruption.
     4 = AutoLearn failed, probably due to drive or compass failure.
     5 = AutoLearn failed, probably due to motor current limiting.
     6 = AutoLearn failed, probably due to boat spinning.
7. If the AutoLearn was successful, hold down **standby** for 2 seconds to store the new settings.



Commissioning complete

Your SPX-5 Tiller system is now commissioned and ready for use.

After having used your SPX-5 Tiller system, you may decide to change the value of some parameters to improve pilot performance with your boat. If you feel this is necessary, use the appropriate procedures under *Manual setup*, below.

3.2 Manual setup

Checking SPX-5 Tiller system operation

Before manually adjusting any of these settings, familiarize yourself with basic SPX-5 Tiller system operation, as follows:

1. Steer onto a compass heading and hold the course steady at a normal cruising speed. If necessary, steer the boat manually for a short time to check how the boat steers.
2. Press `auto` to lock onto the current heading. The SPX-5 Tiller system should hold the locked heading in calm sea conditions.
3. Use `-1`, `+1`, `-10` and `+10` and observe how the SPX-5 Tiller system alters the course to port and starboard.
4. Press `standby` to return to manual steering.

If you feel you need to fine tune the SPX-5 Tiller system performance, you can do so by using one or more of the procedures below to adjust:

- Response level.
- Rudder gain.
- Counter rudder.
- AutoTrim.

Over time you may wish to repeat these adjustments using a range of sea conditions and headings to achieve optimum all-round performance for your particular vessel and preferences.

Adjust these settings when motoring your boat at cruising speed.

Response level

The principal method of adjusting the performance of an SPX-5 Tiller system is by changing the response level. This is the only user adjustment you should need to make to the SPX-5 Tiller system on a regular basis. This controls the relationship between the SPX-5 Tiller system's course keeping accuracy and the amount of helm/drive activity.

Screen Text	Effect on operation
RESPONSE 1-3	This setting minimizes the amount of rudder activity but may compromise short-term course keeping accuracy,
RESPONSE 4-6	This setting gives good course keeping with crisp, well controlled turns under normal operating conditions.
RESPONSE 7-9	This setting provides the tightest possible course keeping and greatest rudder activity. This can lead to a rough passage in open waters as the SPX-5 Tiller system may fight the sea.

To **temporarily** change the response level:

1. Press -1 and +1 or resp to access the **RESPONSE** screen.
2. Use -1 or +1 to adjust the setting.
3. Press disp to confirm the change.

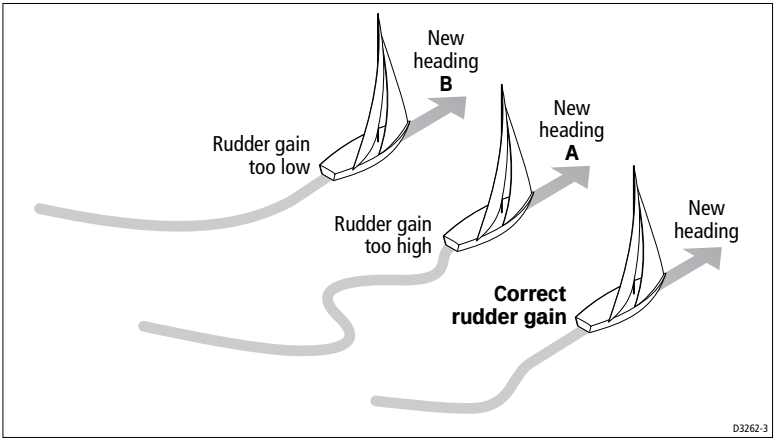
Rudder gain

Boats can vary widely in their response to helm, and by adjusting the rudder gain you can change the SPX-5 Tiller system's steering characteristics. Rudder gain is a measure of how much helm the SPX-5 Tiller system applies to correct course errors – higher settings mean more rudder is applied.

Complete the following test to determine whether the rudder gain is set correctly:

1. Set RESPONSE to level 5 (see above).
2. Motor your boat to a typical cruising speed in clear water:
   It is easier to recognize the steering response in calm sea conditions where wave action does not mask steering performance
3. Press auto to enter Auto mode, then alter course by 40°:
   - if the rudder gain is adjusted correctly, the 40° course change should result in a crisp turn followed by an overshoot of no more than 5°.
   - If the rudder gain setting is too high, the 40° course change will result in a distinct overshoot of more than 5° and there may be a distinct 'S' in the course, as at **(A)**.
     Correct this oversteer by **reducing** the rudder gain setting.

- If the rudder gain is too low, the boat's performance will be sluggish – it will take a long time to make the 40° turn and there will be no overshoot **(B).** Correct this understeer by **increasing** the rudder gain setting.



To adjust the rudder gain:

1. Access the **RUDD GAIN** screen in Dealer calibration (see *page 51*).
2. Use -1 or +1 to adjust the rudder gain.
3. Press and hold standby for 2 seconds to save the changes.
4. Press auto to check the SPX-5 Tiller system performance in Auto mode.

Counter rudder

Counter rudder is the amount of rudder the SPX-5 Tiller system applies to try to prevent the boat from yawing off course. Higher counter rudder settings result in more rudder being applied.

Checking

To check the counter rudder setting:

1. Set **RESPONSE** to level **5**.
2. Motor your boat at cruising speed in clear water.
3. Press auto to switch the SPX-5 Tiller system to Auto mode, then make a 90° course change:
   - When gain and counter rudder are both set correctly, the boat performs a smooth continuous turn with minimal overshoot
   - If the counter rudder is too low, the boat will still overshoot
   - If counter rudder is too high, the boat will 'fight the turn' and make a series of short, sharp turns: this results in a very 'mechanical' feel as the boat changes course

Adjusting

To adjust the counter rudder:

1. Access the **COUNT RUD** screen in Dealer calibration.
2. Use the -1 or +1 keys to adjust the counter rudder.

3. Press and hold standby for 2 seconds to save the changes.
4. Press auto to check the SPX-5 Tiller system performance in Auto mode.

AutoTrim

You may also wish to adjust the AutoTrim setting. AutoTrim determines how quickly the SPX-5 Tiller system applies 'standing helm' to correct for trim changes, caused, for example, by changes in the wind load on the superstructure, or an imbalance of engines.

Increasing the AutoTrim level reduces the time the SPX-5 Tiller system takes to get back onto the correct course, but makes the boat less stable. If the SPX-5 Tiller system:

- Gives unstable course keeping and the boat 'snakes' around the desired course, **decrease** the AutoTrim level.
- Hangs off course for excessive periods of time, **increase** the AutoTrim level.

Adjusting

Before attempting to adjust the AutoTrim setting, ensure you have sufficient experience using your SPX-5 Tiller system.

If you need to adjust AutoTrim, go up one level at a time and use the lowest acceptable value. The range of settings is from **OFF** (no trim correction) to **4** (fastest trim correction).

To adjust the AutoTrim:

1. Access the **AUTOTRIM** screen in Dealer calibration, then:
2. Use -1 or +1 to adjust the AutoTrim level.
3. Press and hold standby for 2 seconds to save the changes.
4. Press auto to check the SPX-5 Tiller system performance in Auto mode.

Chapter 4: SPX-5 Tiller system settings

4.1 Introduction

This chapter describes the SPX-5 Tiller system calibration settings and the factory default settings. The calibration settings can be adjusted to best suit your operating requirements, but as many will have been adjusted to optimum values when commissioning the system, they should not require further change.

If you change the calibration settings after the SPX-5 Tiller system has been commissioned, you do not need to repeat the commissioning process. However, DO NOT manually adjust autopilot settings before the commissioning procedures in *Chapter 3* have been completed.

Calibration modes

There are four calibration modes, namely Display calibration, User calibration, Seatrial calibration and Dealer calibration.

Each calibration mode uses a series of screens to set calibration values.

Display calibration

The items in Display calibration affect the SPX-5 Tiller system Pilot Controller. They are stored in the controller and do not affect any other controllers connected through SeaTalk.

You can adjust the Display calibration settings as often as necessary – for example, to add or change information displayed on data pages.

User calibration

The User calibration mode includes settings that you may need to adjust on a regular basis to respond to changing conditions.

Seatrial calibration

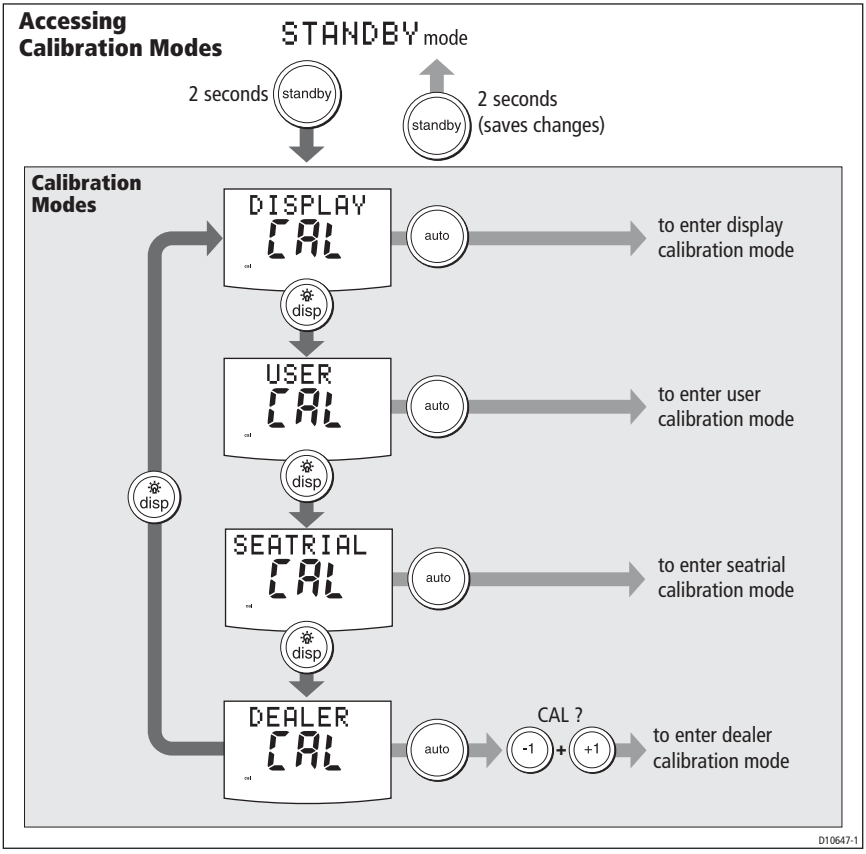
The Seatrial calibration mode is used ONLY when commissioning your SPX-5 Tiller system, as described in *Chapter 3,* so is not described again here. **Do not access Seatrial calibration during normal operation**.

Dealer calibration

The Dealer calibration mode includes items that have a significant impact on operation and can affect your boat's safety.

After you have completed the initial installation and seatrial, you should not normally need to alter the Dealer calibration values.

Accessing the Calibration modes



Adjusting calibration values

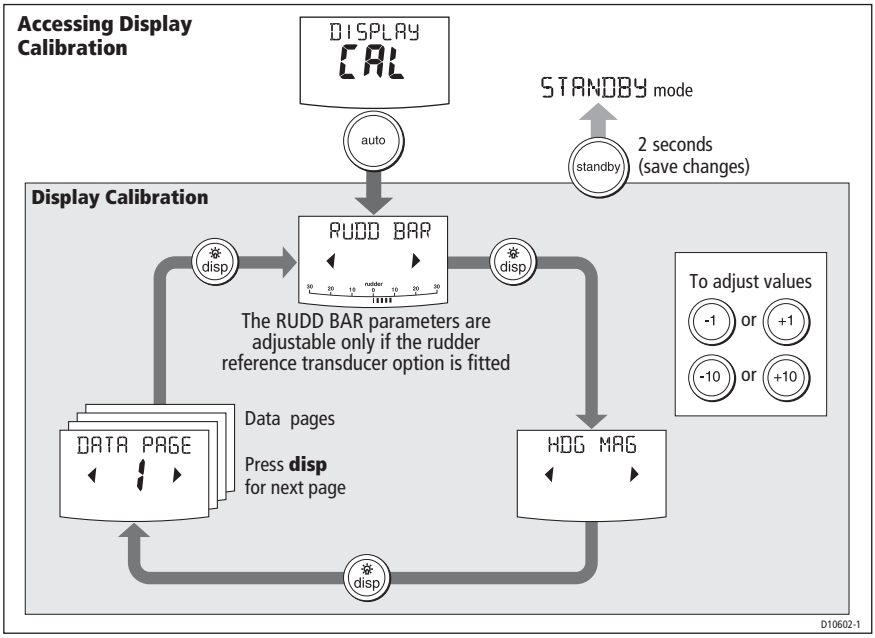
To adjust calibration values;

1. Access the required calibration mode (refer to the diagram above).
2. Press disp to scroll through the available options. To view the previous option, press and hold disp for 1 second.
3. Use -1, +1, -10 and +10 to change the values

When you have made all required changes, press and hold standby for 2 seconds to save changes and exit.

4.2 Display calibration

Display calibration provides settings to adjust the information displayed on the Pilot Controller.



RUDD BAR screen

This screen gives you access to the other Display calibration screens.

HDG screen

You can choose whether to use magnetic or true heading data values. The options are:

- **HDG MAG** - Magnetic heading. If you select this, the screen will indicate **MAG** for heading values, during normal operation.
- **HDG TRUE** - True heading. If you select this the screen will indicate **TRUE** for heading values, during normal operation.

Data pages

The Pilot Controller has fifteen user-configurable data pages. Each data page can be configured to display SeaTalk/NMEA data, which can be viewed during normal operation (see *SmartPilot-X5 Tiller system Operating Guide*).

The default data page settings are:

Data Page	Default Setting
1	**XTE** (Cross Track Error)
2	**BTW** (Bearing to Waypoint) - see Note below
3	**DTW** (Distance to Waypoint) - see Note below
4	**RESPONSE**
Remaining pages	**NOT USED** (see *Setting up data pages* below)

Setting up data pages

When setting up your data pages, we recommend:

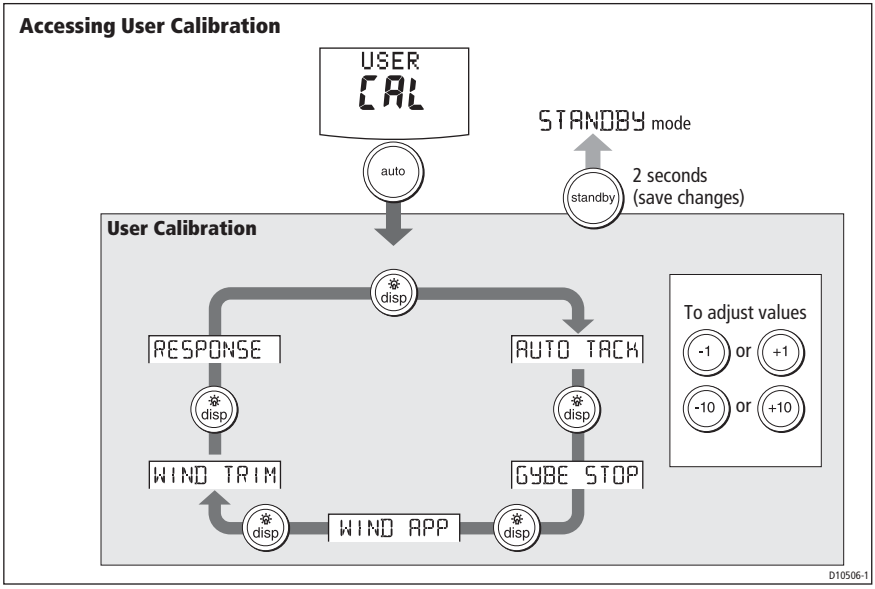
- You set data pages you do not need to **NOT USED**, as these will then not be displayed during normal operation, leaving just the data pages that you do want for you to scroll to.
- You retain the **BTW** and **DTW** data pages. If your SPX-5 Wheel system receives a man overboard (MOB) message, these data pages will show the bearing and distance to the MOB location.

Available Data Pages	Displayed as
Speed Knots	**SPEED KTS**
Log	**LOG XXXX**.X
Trip	**TRIP XXX.X**
Average Speed	**AV. SPD**
Wind Direction	e.g. **WIND PORT**
Wind Speed	**WIND KTS**
Depth Metres	**DEPTH M** - see Note below
Depth Feet	**DEPTH FT** - see Note below
Depth Fathoms	**DEPTH FA** - see Note below
Heading	**HEADING**
Water Temperature, Degrees C	**WATER °C** - see Note below
Water Temperature, Degrees F	**WATER °F** - see Note below
Course Over Ground	**COG**
Speed Over Ground, Knots	**SOG KTS**
Cross Track Error	**XTE**
Distance to Waypoint	**DTW**

Available Data Pages	Displayed as
Bearing to Waypoint	**BTW**
Rudder Gain	**RUDD GAIN**
Response	**RESPONSE**
Watch	**WATCH** - used to control the Watch timer
Universal Time Coordinated	**UTC**

Note: *There are 3 depth pages (meters, feet and fathoms) and 2 water temperature pages (°C and °F). The SPX-5 Tiller system will display the depth data or water temperature in the units defined by data page you select.*

4.3 User calibration



For information on how to access User calibration, see *Accessing the Calibration modes*.

The User calibration mode includes settings that you may need to adjust on a regular basis to respond to changing conditions.

AutoTack

Use this screen to select how the vessel performs when using AutoTack. You can either:

- Set a default AutoTack angle. This is the angle through which the boat will turn when an AutoTack is performed.
  or
- Select Relative Tack operation. With Relative Tack selected, the apparent wind angle when AutoTack is initiated, is mirrored the other side of the wind, on the opposite tack.

Screen Text	Options
AUTO TACK	40° to 125° in 1° steps

Setting default AutoTack angle

To set the required AutoTack angle:

- If the SPX-5 Tiller system is receiving wind information, set the AutoTack angle to the required change of heading.
- If the SPX-5 Tiller system is not receiving wind information, set the AutoTack angle to 20° greater than the actual required change of heading.
  For example, to tack through 80° (i.e when sailing at 40° to the wind), set the AutoTack angle to 100°.

Selecting Relative Tack

To select Relative Tack, use -1 and -10, to reduce the tack angle value to 30°. This action selects Relative Tack and the screen displays **rEL**, to indicate this.

Gybe inhibit

With gybe inhibit on:

- You will be able to perform an AutoTack into the wind
- The SPX-5 Tiller system will prevent the boat from performing an AutoTack away from the wind, to prevent accidental gybes.

With gybe inhibit off, you can perform an AutoTack into or away from the wind.

Screen Text	Options
GYBE STOP	ON (Default) = Gybe inhibit on (gybes prevented) OFF = Gybe inhibit off (gybes permitted)

Wind selection

This screen determines whether the boat steers to apparent or true wind in Wind Vane mode.

Options	
WIND APP (Default)	SPX-5 Tiller system steers to apparent wind angle
WIND TRUE	SPX-5 Tiller system steers to true wind angle

WindTrim

WindTrim controls how quickly the SPX-5 Tiller system responds to changes in the wind direction. Higher wind trim settings will result in a system that is more responsive to wind changes.

Screen Text	Options
WIND TRIM	Range = 1 to 9 1 to 3 - Least responsive to wind changes (less system activity) 4 to 6 - Moderate response to wind changes 7 to 9 - Most responsive to wind changes (more system activity)

Response level

This sets the default SPX-5 Tiller system response level. The response level controls the relationship between course keeping accuracy and the amount of helm/drive activity. You can make temporary changes to response during normal operation, as described in *Chapter 1, SPX-5 Tiller system Operation*.

Screen Text	Options
RESPONSE	Range = 1 to 9 Level 1 to 3 minimizes the amount of pilot activity. This conserves power, but may compromise short-term course-keeping accuracy. Level 4 to 6 should give good course keeping with crisp, well controlled turns under normal operating conditions Level 7 to 9 gives the tightest course keeping and greatest rudder activity (and power consumption). This can lead to a rough passage in open waters as the SPX-5 Tiller system may 'fight' the sea.

4.4 Dealer calibration

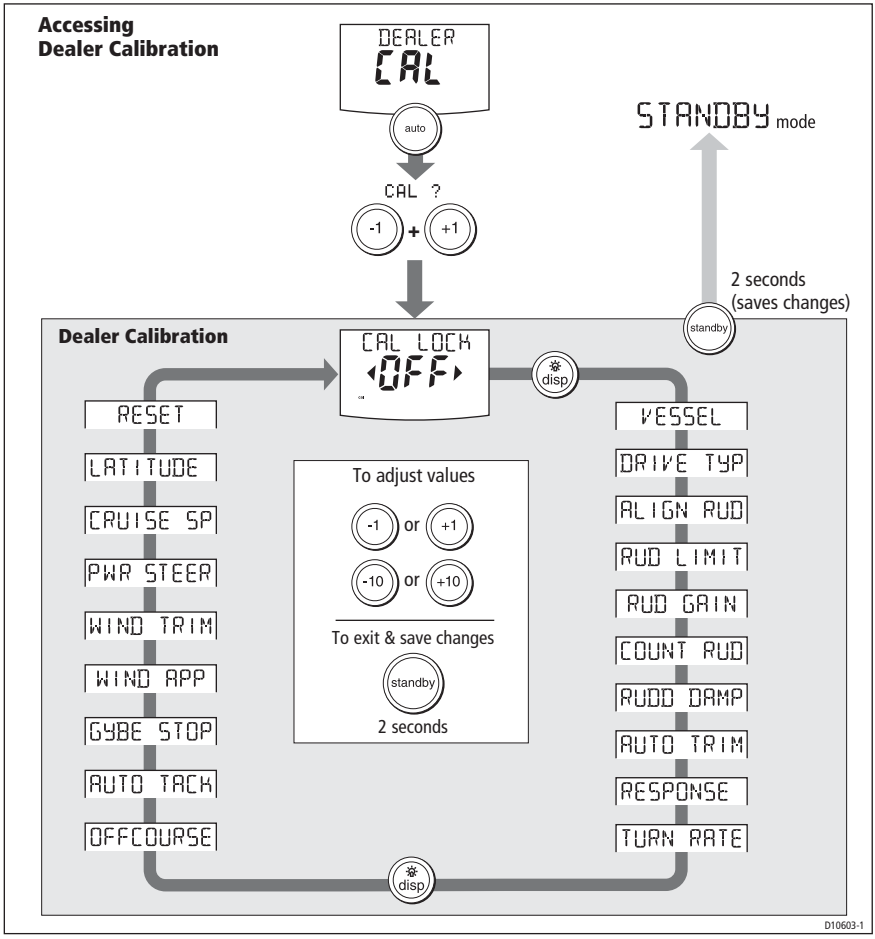
For information on how to access Dealer calibration see *Accessing the Calibration modes*.

WARNING: Dealer calibration

Changing the Dealer calibration values can have a significant affect on the SPX-5 Tiller system steering characteristics and therefore on the safety of your boat.

Some Dealer calibration values are adjusted during the commissioning process (see *Chapter 3: Commissioning & setup*), and once the SPX-5 Tiller system has been commissioned you should not normally need to change Dealer calibration values.

However if you decide you want to change values in Dealer calibration, be aware that the Dealer calibration mode includes items that have a **significant impact on SPX-5 Tiller system operation and can affect your boat's safety**.



Seatrial calibration lock

This screen controls the access to Seatrial calibration.

Options	
CAL LOCK OFF	Calibration lock off – Seatrial calibration can be accessed (default)
CAL LOCK ON	Calibration lock on – Seatrial calibration cannot be accessed

Vessel type

Selecting the correct vessel type, enables the SPX-5 Tiller system to set appropriate values for other calibration settings, to give optimum performance. Refer to the table on *page 58* for default values.

The correct setting for the SPX-5 Tiller system is **SAIL BOAT**. This should be set when commissioning the SPX-5 Tiller system.

Drive type

The drive type setting controls how the SPX-5 Tiller system drives the steering system.

The correct setting for the SPX-5 Tiller system is **3**.This should be set when commissioning the SPX-5 Tiller system.

Align rudder

The align rudder screen is displayed only if the rudder reference option is fitted.

If the rudder reference option is fitted, use this screen is used to calibrate the rudder bar display. This should be set when commissioning the SPX-5 Tiller system (see *page 34*).

Screen Text	Range
ALIGN RUD	-9° to +9° in 1° steps

Rudder limit

This screen is not displayed if the rudder reference option is not fitted.

If the rudder reference option is fitted, use the rudder limit screen to set the limits of the rudder control just inside the mechanical end stops, to avoid putting the steering system under unnecessary load. You should adjust this setting when commissioning the SPX-5 Tiller system (see *page 34*).

Screen Text	Range
RUD LIMIT	10° to 40° in 1° steps

Rudder gain

Rudder gain is a measure of how much helm the SPX-5 Tiller system applies to correct course errors. The higher the setting the more rudder will be applied.

The rudder gain setting is set automatically as part of the AutoLearn process (see *page 41*).

Screen Text	Range
RUDD GAIN	1 to 9

Counter rudder

Counter rudder is the amount of rudder the SPX-5 Tiller system applies to try to prevent the boat from yawing off course. Higher counter rudder settings result in more rudder being applied.

The default counter rudder gain is set during the initial seatrial, as part of the AutoLearn process (see *page 42*).

Screen Text	Range
COUNT RUD	1 to 9 (Do NOT set to 0)

Rudder damping

If the SPX-5 Tiller system 'hunts' when trying to position the rudder, adjust the rudder damping value to minimize this. Increasing the rudder damping value reduces hunting. Increase the damping one level at a time until the autopilot stops hunting, and always use the lowest acceptable value.

Screen Text	Range
RUDD DAMP	1 to 9

AutoTrim

The AutoTrim setting determines the rate at which the SPX-5 Tiller system applies 'standing helm' to correct for trim changes caused by varying wind loads on the sails or superstructure.

The default AutoTrim is set as part of the AutoLearn process (see *page 43*).

If you need to change the setting, increase the AutoTrim one level at a time and use the **lowest** acceptable value:

- If the SPX-5 Tiller system gives unstable course keeping or excessive drive activity with a change in the heel angle, decrease the AutoTrim level.
- If the SPX-5 Tiller system reacts slowly to a heading change due to a change in the heel angle, increase the AutoTrim level
- If the AutoTrim level is too high, the boat will be less stable and snake around the desired course.

Setting	Effect
AUTO TRIM OFF	No trim correction
AUTO TRIM 1 to **6**	Auto trim applied: 1 = Slowest, 4= Fastest

Response level

This sets the default SPX-5 Tiller system response level setting. The response level controls the relationship between course keeping accuracy and the amount of helm/drive activity. You can make temporary changes to response during normal operation (see your *Operating Guide* for details).

Screen Text	Options
RESPONSE	Range = 1 to 9 Level 1 to 3 minimizes the amount of pilot activity. This conserves power, but may compromise short-term course-keeping accuracy Level 4 to 6 should give good course keeping with crisp, well controlled turns under normal operating conditions Level 7 to 9 gives the tightest course keeping and greatest rudder activity (and power consumption). This can lead to a rough passage in open waters as the SPX-5 Tiller system may 'fight' the sea.

Turn rate limit

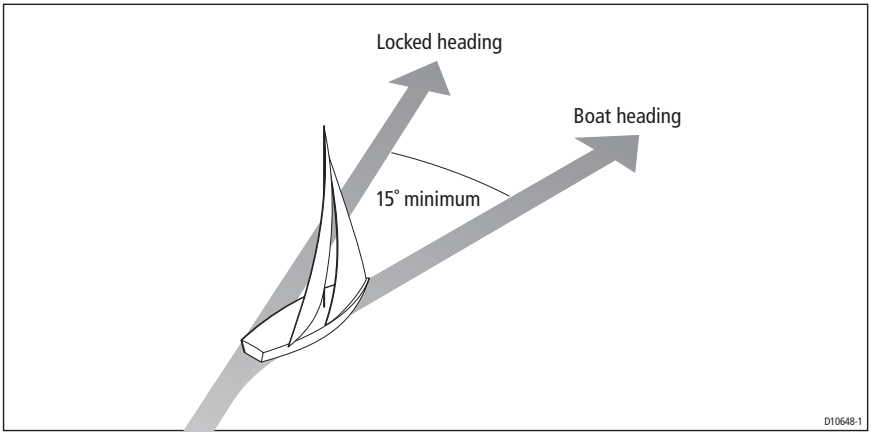
This limits your boat's rate of turn under SPX-5 Tiller system control.

Screen Text	Range
TURN RATE	1° to 30° per second in 1° steps

Off course angle

This screen determines the angle used by the OFF COURSE alarm (see your *Operating Guide*). The OFF COURSE alarm operates if the pilot strays off course by more than the specified angle for more than 20 seconds.

Screen Text	Range
OFF COURSE	15° to 40° in 1° steps



AutoTack angle

The AutoTack angle is the angle through which the boat will turn when you select an automatic tack.

Screen Text	Options
AUTO TACK	40° to 125° in 1° steps

Gybe inhibit

With gybe inhibit on:

- You will be able to perform an AutoTack into the wind
- The SPX-5 Tiller system will prevent the boat from performing an AutoTack away from the wind

With gybe inhibit off, you can perform an AutoTack into or away from the wind.

Screen Text	Options
GYBE STOP	On (Default) OFF

Wind selection

Note: *Only available if appropriate wind data is available.*

This screen determines whether the boat steers to apparent or true wind in Wind Vane mode.

Options	
WIND APP (Default)	SPX-5 Tiller system steers to apparent wind angle
WIND TRUE	SPX-5 Tiller system steers to true wind angle

WindTrim

WindTrim controls how quickly the SPX-5 Tiller system responds to changes in the wind direction. Higher wind trim settings will result in a system that is more responsive to wind changes.

Screen Text	Options
WIND TRIM	Range = 1 to 9 Lower values (1 to 3) = SPX-5 Tiller system responds to longer term wind changes (less system activity) Typical values = 4 to 6 Higher values (7 to 9) = SPX-5 Tiller system responds to shorter term wind changes (more system activity)

PowerSteer

If you have a joystick connected to your SPX-5 Tiller system, use this screen to select the required joystick mode of operation. For detailed operating information, refer to the guide supplied with the joystick.

Options	
OFF	Joystick off
1	1 = Proportional power steer Proportional power steer applies rudder in proportion to joystick movement – the further the joystick is held over, the greater the applied rudder.
2	2 = Bang-bang power steer Bang-bang power steer applies continuous rudder in the direction of the lever movement – to improve control, the speed of rudder movement changes with the angle of the lever. For maximum speed, push the lever hardover. If you return the lever to the center position, the rudder will remain in its current position.

Cruise speed

Set the cruise speed to the boat's typical cruising speed. If neither the speed through the water nor speed over ground are unavailable via SeaTalk or NMEA, the SPX-5 Tiller system will use the cruise speed value you set here as a default when calculating course changes.

Screen Text	Range
CRUISE SP	4 to 60 knots

Latitude

If valid latitude data is available via SeaTalk or NMEA, the SPX-5 Tiller system will use this data instead of the calibration value.

Screen Text	Range
LATITUDE	0° to 80° in 1° steps

System reset

CAUTION: Losing settings at system reset

Do NOT carry out a System RESET unless advised to do so by a Raymarine dealer. If you complete a reset you will lose the SPX-5 Tiller system calibration settings. You will then need to repeat the SPX-5 Tiller system commissioning process.

Carrying out a System reset will reset User calibration, Seatrial calibration and Dealer calibration settings to their default values.

Note: *The Display calibration settings will not change, as these are stored in each individual controller*

To carry out a system reset:

1. Select the System reset (**RESET**) screen in Dealer calibration.
2. Press +1 then press **AUTO**.
3. The screen will then show an **ARE YOU SURE** message:
   - Press auto to cancel the reset

   or
   - Press +1 again to select YES and reset the SPX-5 Tiller system.
4. You will then see the **CAL LOCK** screen:
   - Hold down standby for 2 seconds to save the new default settings, then turn the SPX-5 Tiller system computer power off and back on.

If you reset the system parameters, you must carry out the SPX-5 Tiller system commissioning process before using the SPX-5 Tiller system again.

4.5 System defaults

Calibration Lock	OFF	Turn Rate Limit	7
Vessel Type	SAIL BOAT	Off Course Angle	20
Drive Type	3	AutoTack Angle	100
Rudder Alignment	0	Gybe Inhibit	ON
Rudder Limit	30	Wind Type	APP
Rudder Gain	2	Wind Trim	5
Counter Rudder	2	Power Steer (Joystick)	OFF
Rudder Damping	2	Cruise Speed	8
AutoTrim	1	Latitude	0
Response:	5	Autopilot Reset	OFF

Appendix 1: NMEA 0183 sentences

The SPX-5 Tiller Course Computer computer supports the following NMEA0183 sentences.

NMEA0183 to Course Computer

Header	Data in
APB	Cross track error, bearing to waypoint, waypoint number
BWC BWR	Bearing to waypoint, distance to waypoint, waypoint number, time
GGA GLL	Latitude/longitude, time
HDG HDM HDT	Heading
MWV	Apparent wind angle, apparent wind speed
RMA	Course over ground (COG), speed over ground (SOG), latitude/longitude, variation
RMB	Cross track error, bearing to waypoint, distance to waypoint, waypoint number
RMC	Course over ground (COG), speed over ground (SOG), latitude/longitude, time, variation
VHW	Speed through water, heading
VTG	Course over ground (COG), speed over ground (SOG)
XTE	Cross track error
ZDA	Time, date

NMEA0183 from Course Computer

NMEA 0183 sent	Information sent
HDG	Heading
RSA	Rudder angle. Available only if Rudder Reference option is fitted.

***** The computer will only transmit these items if it has received the appropriate data.

Appendix 2: SPX-5 Tiller system specifications

Course Computer

Nominal supply voltage	12 V dc (10 A fuse protection at distribution panel) (10 A thermal circuit breaker protection at distribution panel)
Operating voltage range	10 V to 16 V dc
Power consumption (standby)	200 mA
Gyro	Built in
Environmental conditions: • operating temperature • non-operating temperature • relative humidity limit • water protection	 -10°C to 55°C (14°F to 131°F) -20°C to 70°C (-4°F to 158°F) 80% Drip resistant when mounted vertically
Storage conditions when packed: • temperature range • relative humidity limit	 -5°C to 50°C (23°F to 122°F) 75%
Dimensions:	Width: 240 mm (9 $^{7}/_{16}$“), Height: 170 mm (6 $^{11}/_{16}$“), Depth: 55 mm (2 $^{3}/_{16}$“)
Weight	600 g (1 lb 5.2oz)
Inputs	Fluxgate Compass, NMEA 0183 v3.01, SeaTalk (x2), SeaTalk^{ng}, power
Outputs	NMEA 0183 v3.01, SeaTalk (x2), drive motor, drive clutch
Raymarine drive compatibility:	ST4000 Tiller Drive (standard and GP) (as supplied with product) ST4000 Wheel Drive
Drive motor output:	Continuous 5 A at nominal 12 V
SeaTalk output	2A at 12 V (fuse protected at 2A)
NMEA 0183 v3.01 inputs/outputs	See *Appendix 1: NMEA 0183 sentences*
NMEA fast heading output	HDG 5 Hz 0.1° resolution
Fuses	Standard automotive blade fuses to protect: Power Terminals - 10 A SeaTalk Terminals - 2 A
EMC compliance:	Europe 2004/108/EC (EMC) Australia and New Zealand: C-Tick, Compliance Level 2

Tiller Drive

SPX-5 Tiller Drive unit technical specification	
Nominal supply voltage	12 V dc
Operating voltage range	10 V to 16 V dc
Drive Speed	5 seconds lock to lock
Environmental conditions: • Operating temperature • Non-operating temperature • Water protection	 -10°C to 55°C (14°F to 131°F) -20°C to 70°C (-4°F to 158°F) To IPX6 standard
Storage conditions when packed: • Temperature range • Relative humidity limit	 -20°C to 50°C (-4°F to 122°F) 75%
Inputs	Drive power from compatible Course Computer.
Servicing	Raymarine approved service at 1000 hrs intervals
EMC compliance:	Europe 2004/108/EC (EMC) Australia and New Zealand: C-Tick, Compliance Level 2

Pilot Controller (ST6002)

Nominal supply voltage:	12 V DC via SeaTalk
Operating voltage range:	10 V to 15 V DC
Current consumption (in Standby mode)	60 mA (less than 200 mA with full lighting)
Operating temperature:	0 °C to +70 °C (32 °F to 158 °F)
Water protection:	waterproof to CFR46
Overall dimensions: width height depth	 110 mm (4.33 in) 115 mm (4.53 in) 41 mm (1.62 in)
Keypad:	8 button illuminated keypad
Liquid Crystal Display (LCD):	shows heading, locked course and navigational data, and up to 15 data pages
LCD illumination:	3 brightness levels + off
Input connections:	SeaTalk (x2) and NMEA 0183
Output connections:	SeaTalk (x2)
EMC compliance:	Europe 2004/108/EC (EMC) Australia and New Zealand: C-Tick, Compliance Level 2

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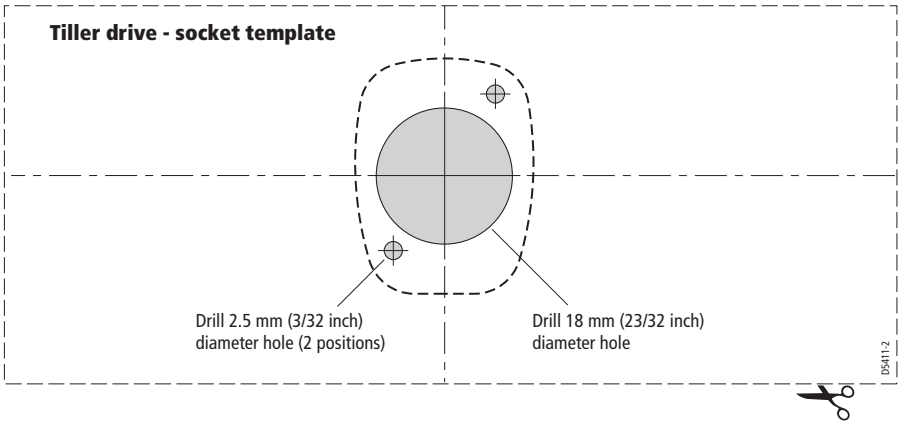
Tiller drive - socket template
Drill 2.5 mm (3/32 inch)
diameter hole (2 positions)
Drill 18 mm (23/32 inch)
diameter hole
D5411-2